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ABSTRACT

Estuaries are marine systems that serve as nurseries for animals, links in the migratory pathways, and habitat for a complex community of organisms. This curriculum guide intended for use at the middle school level is designed for use with the on-site program developed by the Padilla Bay National Esturine Research Reserve (Washington). The guide is divided into three main sections: (1) pre-trip information, activities, and resources; (2) on-site program materials; and (3) post-trip ideas that integrate the trip with language arts, social studies, mathematics, science, physical education, creative thinking, art, music, and health. All three sections are considered essential for the success of the program. Other sections in the guide contain information about the plant, human, and animal life related to estuaries and a form to evaluate the effectiveness of the program. (MDH)

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ED 371 941

Padilla Bay

THE ESTUARY GUIDE

LEVEL 2

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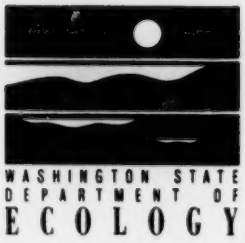

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Padilla Bay National
Estuarine Research Reserve
Breazeale Interpretive Center

THE ESTUARY GUIDE

LEVEL 2

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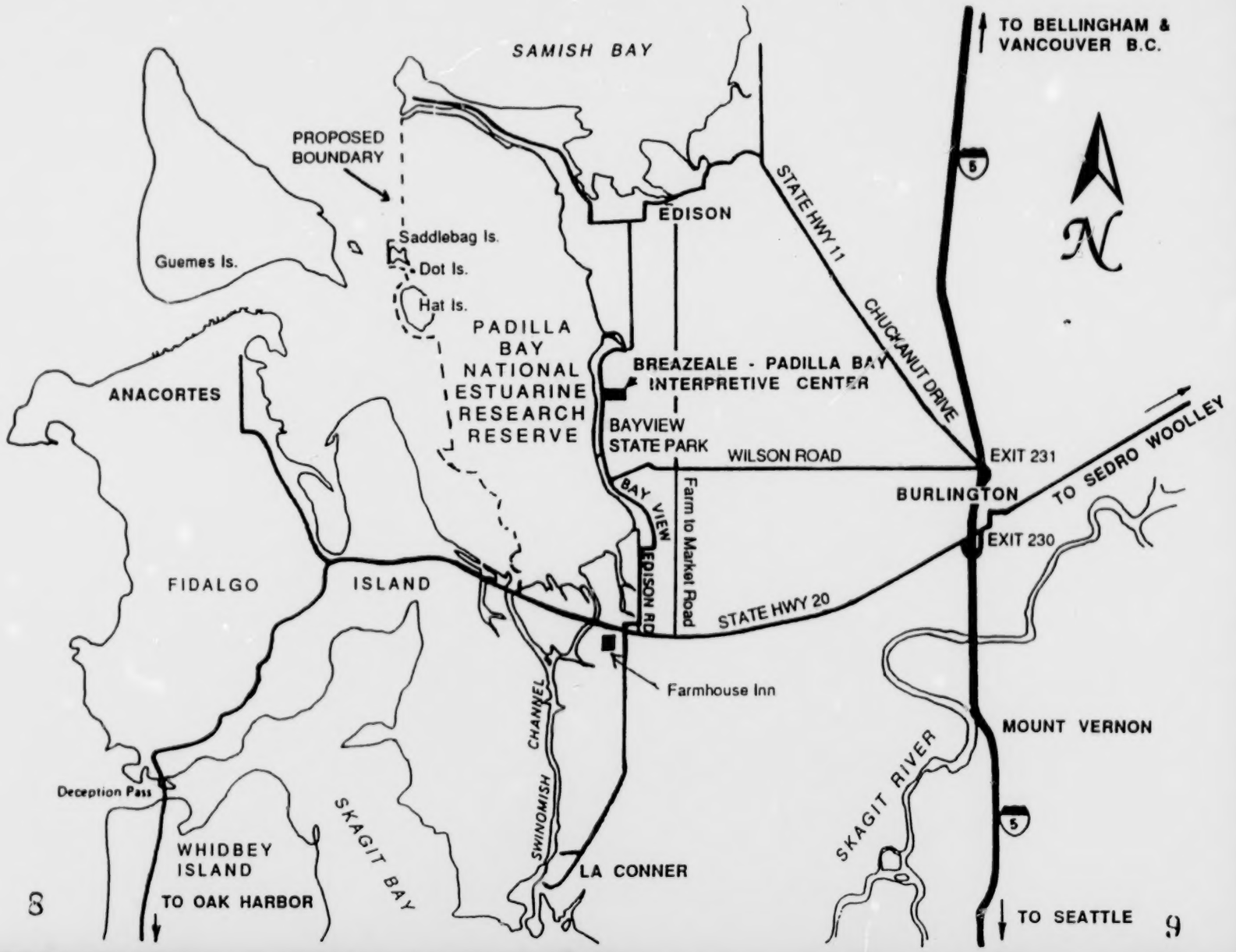
We are a National Estuarine Research Reserve, one of 18 in the country and the only one in Washington State. We are set up as a natural "field laboratory" for studying and teaching about the importance of wetlands and shorelands, estuaries in particular.

Concern for these areas has been growing along with both an increasing awareness of their value and of the abuses we have carelessly inflicted upon them. It is only in the past few decades that we are realizing the richness in our backyards.

There is a wealth of beauty, humor and truths stranger-than-fiction out there waiting to be understood. May these beginning activities lead to a closer bonding between the student, of any age, and the natural world.

Padilla Bay



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This guide is designed for use with the on-site, all day program for upper elementary and middle school grades, though it can be easily adapted for use with those younger and older.

It is color-coded and divided into three main sections:
•PRE-TRIP information, activities and resources (peach)
•ON-SITE program materials (cream)
•POST-TRIP ideas (blue)
ALL student worksheets are white for copying

All three sections are essential for the success of the program. Students feel more comfortable and confident if they have been introduced to the key vocabulary words before they arrive, the on-site materials will help you to familiarize yourself to the day, and the post-trip activities extend the learning into the classroom.

The activities are designed to weave together many subjects and many ways of learning, with the hope that some can fit comfortably into your classwork and with your unique style of teaching.

The on-site activities focus on the "active" with the learner tapping into his or her senses of curiosity and creativity. They include group participation and encourage communication skills. Pre- and post-trip activities encompass these as well as other approaches, some of which are better suited for the classroom.

A Bit About Estuaries...

The Skagit River begins in the North Cascades. It tumbles down mountainsides, spills over waterfalls, runs past towns and under bridges, winds through the fertile Skagit Valley and eventually slows down as it nears its estuary, the Skagit Delta. An estuary: the place where a river meets the sea.

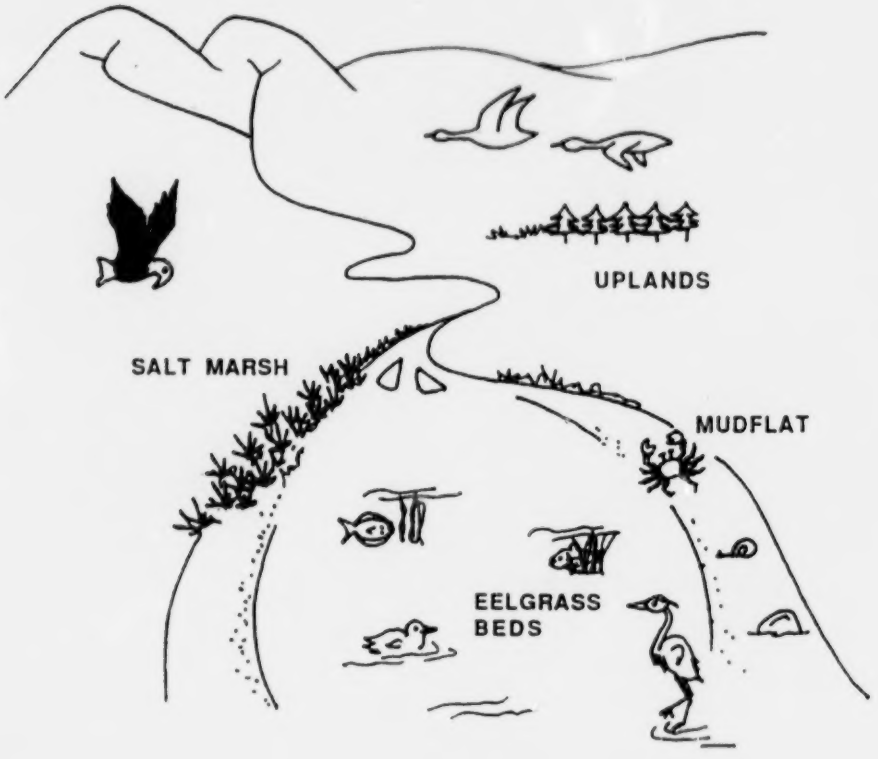
Estuaries are remarkable places, rich with treasures hidden to the casual observer. Life is concentrated here. The amount of plant material produced in an estuary far exceeds that of even our best-tended wheat fields. In turn, plants provide food and shelter for a myriad of animals. The bay is a veritable garden.

Plants

The complex marine food web begins with phytoplankton, the tiny, free-floating plants that thrive in the shallow, sunlit, nutrient-rich water. Phytoplankton belong to a group of plants called "algae". Larger algae are commonly called seaweeds. Another producer is eelgrass (one of the few true flowering marine plants) which literally carpets Padilla Bay and gives the bay its unique character. It offers food and shelter to the many animals that live on and among its blades. Eelgrass is food for many animals, but is perhaps more valuable once it has died and decayed. Broken down by bacteria, these bits of detritus add nutrients or "spice" to the "soup". A third major group of plants consists of the salt marsh plants that form the transition zone between land and water. These specialized plants add nutrients to the bay, filter out toxins from land run-off, and soak up excess rainwater like a sponge.

Animals

The abundant plant life in an estuary attracts an endless variety of animals, for it provides ample food and shelter. Estuaries can be a home, a nursery or a rest stop for migrating animals. Oysters, for example, spend their entire life in an estuary. They begin life as zooplankton and settle down as they mature. Salmon need to spend time in an estuary on their journey to the sea; the bay provides food to grow on as well as a gentle transition stage from the fresh water to the salt. Padilla Bay, like many estuaries, is located on a major flyway and hosts scores of migrating waterfowl, some of which choose to winter here, others which continue southward.



Many other marine animals use the estuary as a nursery for raising their young. Juvenile Dungeness crab are found in large numbers in the shallow waters of an estuary. Virtually every marine animal is, in some way, connected to the richness in an estuary.

"Estuary" comes from the Latin word "aestus", meaning "tides". Twice a day the tides fill and empty the bay. The seasonal cycles and daily fluctuations of tides, salinity and temperature create a unique environment that requires special adaptations of its inhabitants. Yet life forms are numerous and diverse, attesting to the natural wealth in an estuary.

People

People are no exception. We, too, "flock" to estuaries for the natural resources, edible as well as aesthetic, and for the ease of transportation by land, water and air. The scenic backdrop for recreational activities and the peace and beauty at the water's edge lures us. Seven of the world's ten largest cities are built on estuaries; more than half of the U.S. population resides near an estuary; most of the people in Washington state live on the coast, near an estuary (Puget Sound is in itself an estuary) ...and these numbers are steadily increasing.

Growing "appreciation" is a mixed blessing, for the price of development is often a trade-off with the health of the environment. Estuaries have been used and much abused in the past. Seen as barren and muddy wastelands, they have been targeted sites for dredging, diking, dumping of wastes (Chesapeake Bay is on the "critical" list), and development (75% of both San Francisco Bay and the Fraser River estuary have been filled in). Three-fourths of the nation's wetlands have already been destroyed.

We do know how to halt the trend, but it takes more study and an educated, concerned public to help make these decisions. In 1972 the federal government responded to public concern and passed the Coastal Zone Management Act which included the National Estuarine Sanctuary Program, renamed the "National Estuarine Research Reserve System" in the spring of 1986.

We're glad that you are here to learn with us.

Coming to Padilla Bay will be a new and different type of experience for most students and parents. We strongly urge you, the teacher, to visit the Center before your field trip. Three-hour teacher workshops will be offered in early spring to help familiarize you with the site and the program. Our educational staff is small; you will be an integral person throughout the day. We ask that you bring parents at a minimum ratio of one parent to eight students. Please pass on the enclosed information to them.

Included is a checklist for you. Please be sure to complete everything on it. Pay special attention to providing NAME TAGS for all — children and adults, and to having EVERYONE dress appropriately for the weather. A change of clothes may come in handy. It is often colder and windier down at the beach. Being avid northwesterners, we rarely cancel a field trip.

We also ask that you introduce your class to estuaries before they come, using the pre-trip activities on pages 25-53. We will reinforce the key vocabulary words and use them throughout the day. The student text titled "A Bit About Estuaries" will provide basic background information. Making a paper food chain and web will help emphasize this important concept. The "Estuary Search" activity will help students locate Padilla Bay and other estuaries in Washington. If you would like to do more preparation, leafing through the post-trip section may give you ideas.

PRE-TRIP INFORMATION

Teacher Checklist

FOR YOU:

____review the program schedule and your time frame (changes?)

____read through this entire curriculum packet.

____sign up for a three-hour teacher workshop at the Interpretive Center; you are strongly encouraged to do so.

____make sure to send back the evaluation, completed.

WITH ADULT LEADERS:

____arrange for adequate adult supervision: one adult per team of 6-8 students. We cannot carry out the program without this help.

____share with them the following five "Parent Pack" pages and the "Program Schedule" found on pages 62-63.

WITH STUDENTS:

____introduce vocabulary.

____copy and carry out all the pre-trip activities.

____remind everyone that there will be no "souvenirs" collected at the beach.

____divide your class into teams of 6-8 students each.

WITH EVERYONE:

____dress for the weather and mud (rain gear, rubber boots or old shoes and possibly a change of clothes).

____bring a hearty sack lunch.

____name tags for all.

____optional: camera, binoculars, extra goodies.

Welcome to Padilla Bay — students of all ages! Thank you for sharing your time in helping us carry out the day's activities. Your participation makes our program possible.

Your responsibilities:

On the Beach: The class will be divided into teams of 6-8 students with one adult volunteer. Encourage your team to stick together and work as a group.

Each team will work together on a scavenger hunt. Please make sure that students return all rocks to their original position and fill in all holes. After we have gathered to share our discoveries, we ask that you help to return all critters and see that equipment gets cleaned and returned.

At the Center: The Breazeale Interpretive Center houses a variety of exhibits depicting upland and estuarine communities of Padilla Bay. Cedar wood and open fields to mudflats, marshes and eelgrass meadows are illustrated through text, photos, mounts, models and several saltwater aquaria.

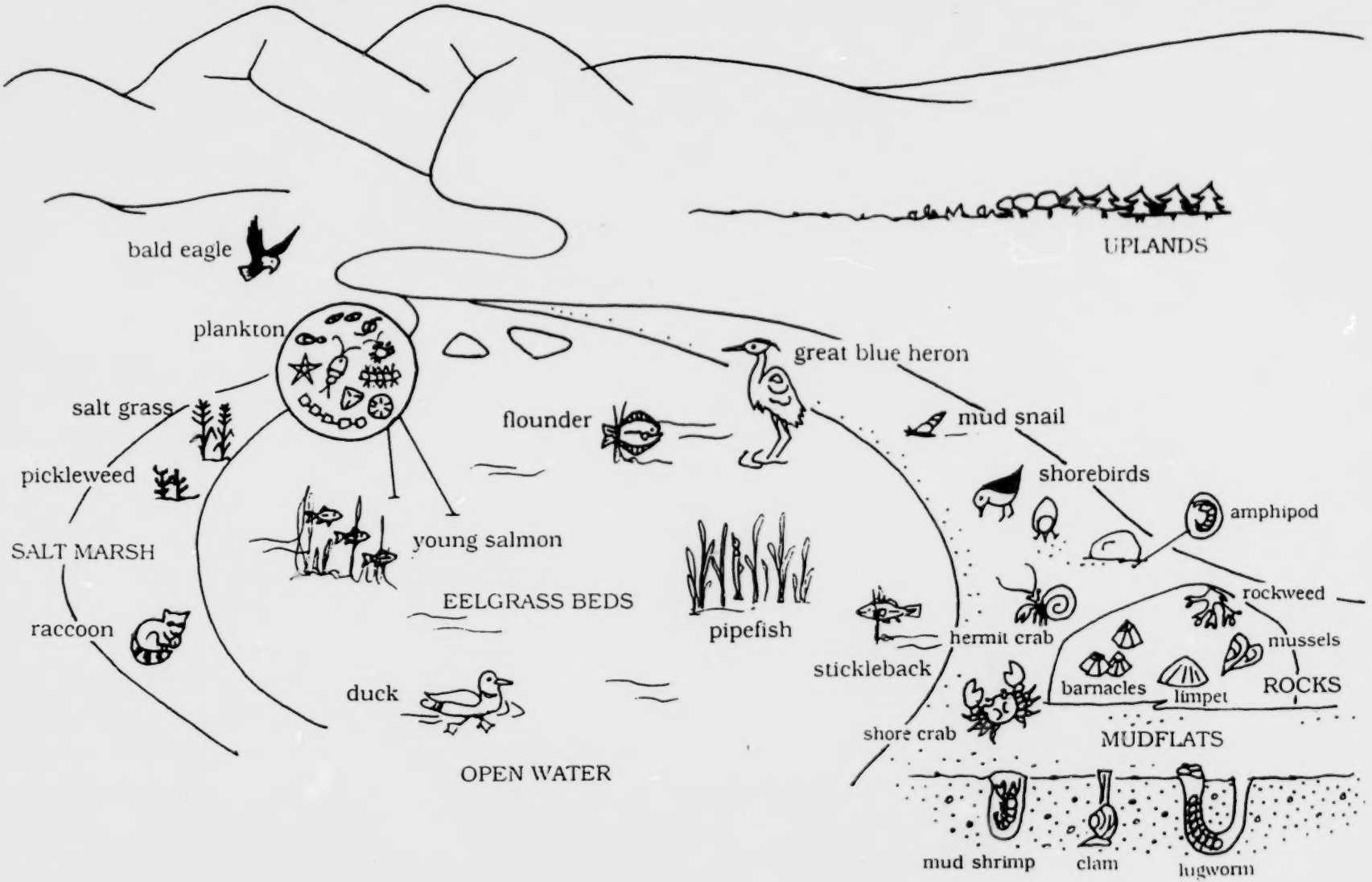
We ask that visitors use only eyes to take in the static exhibits and save other senses for the "hands-on" room set up for children of all ages. There, natural objects, books, games, puppets and microscopes are set out to invite participation.

The questions on a following page are only a guide to aid you in focusing the attention of your group. Please use them as you see fit. Most important is that YOU have a good time, for the more you get involved, the more your group will follow suit. Please help focus attention and keep congestion at bay. Thank you!

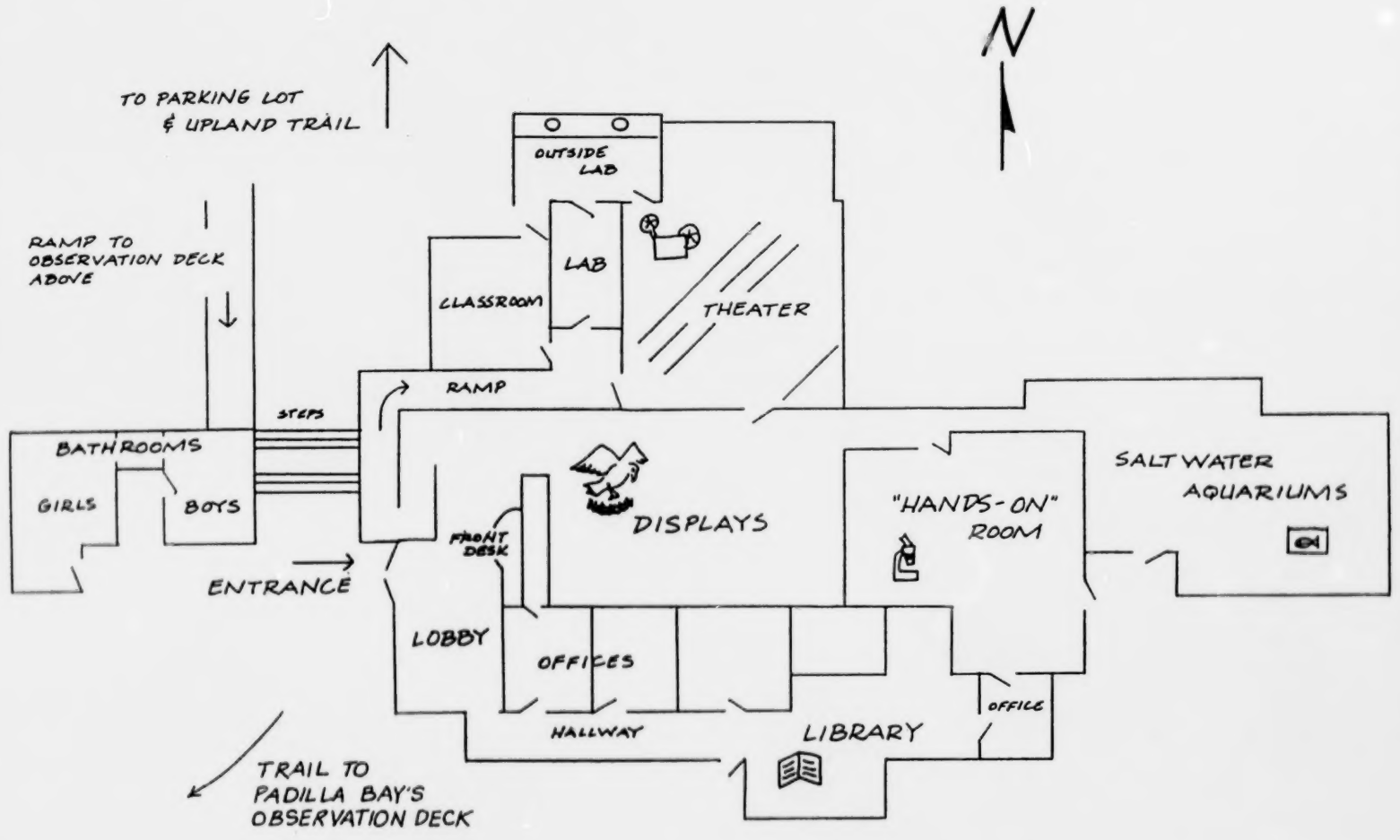
NOTES:

Clothing: a cool rain can smell rich, heighten the vividness of natural colors and be very refreshing, or it can turn a potentially invigorating day sour. A raincoat, waterproof boots and warm clothes are essential. Layers of clothes help to trap insulating air and are best for changing conditions. It's often windier and colder on the beach than at home. Please be prepared for the worst and hope for the best!

Food: eating a high-energy breakfast is a critical beginning to a day in the field. Please advise your class to eat heartily and bring a solid lunch with a "treat". We have nothing edible to offer here at the Center.


bald eagle
UPLANDS
plankton
great blue heron
salt grass
flounder
mud snail
pickleweed
shorebirds
amphipod
SALT MARSH
young salmon
rockweed
EELGRASS BEDS
pipefish
raccoon
hermit crab
mussels
stickleback
barnacles
limpet
ROCKS
duck
shore crab
MUDFLATS
OPEN WATER
mud shrimp
clam
lugworm

THE BREAZEALE - PADILLA BAY INTERPRETIVE CENTER



Padilla Bay

Aquaria Inquiry

1. FIND an animal that can: squeeze through narrow places.. hold still and look like a rock.. bury itself to hide from predators.. use another's shell for a home.
2. Find 3 animals in the eelgrass that are CAMOUFLAGED. With your group vote on the "Best Camouflaged" eelgrass inhabitant. Discuss how camouflage aides in survival.
3. Think of 3 ADAPTATIONS (ways) that animals avoid being eaten. (close up, bury, camouflage of color and body shape, sting, pinch, have spines, 'glue' on algae and sponges)
4. Find one fish that SWIMS constantly and one that RESTS on the bottom. Think of an advantage for each style. (keep moving to avoid being eaten, blend in)
5. Find an animal that has HITCHHIKERS.
6. Think of waves pounding on rocks. What are some ADAPTATIONS to enable animals to avoid this pounding? (hard shell, suction for holding on, ability to hide under rocks and in sand)
7. What BIRD can probe deep in the mud for its dinner? (shorebird) What enables it to do so? (long bill) What might it feed on? (worms, small clams, snails)
8. Crabs are SCAVENGERS, searching out and eating DETRITUS: dead plants and animals. They help to "recycle" nutrients in an estuary by making use of non-living matter. Can you find evidence of detritus in the tanks?
9. Find an animal that moves on THOUSANDS of FEET. (seastar) Seastars have eyespots on the tip of each arm. Can you see them?
10. What are 3 animals adapted for living <u>in</u> the MUD? (shrimps, clams, worms) Give a unique adaptation for each that aids it in living "down under". (see wall model)

11. What makes EELGRASS different from SEAWEED? (reproduces by flowers, has roots not holdfasts, leaves not blades, anchors in mud not onto rocks) Why is eelgrass so important to animals? (food and protection)
12. Why do some RAPTORS (birds of prey) live by estuaries? (abundance of food: shorebirds on mudflats, fishes in water, small rodents in nearby fields)
13. Find out which birds, fishes and mammals live in MARSHES.
14. How do NUTRIENTS from eelgrass get RECYCLED? (bacteria and fungi feed on the dead grass and break it down. These particles are in turn food for plankton and scavengers)
15. How many animals can you find that have hard SHELLS on the outside of their bodies? (snails, clams, barnacles, limpets, shrimps) How does this help them survive? (protection)

Field Trip Guidelines

Many of us hesitate to go outside with our students because we feel that we know so little about the plants and animals around us. But names don't tell us much about the way an animal moves or how it fits into its environment. We learn about our world by watching quietly, listening with open eyes and hearts. So to those of us unaccustomed to such exploring — please relax and enjoy the day, listen to your own adventurous spirit. Let your imagination guide you; the students will follow suit.

The following guidelines were borrowed from "Clearing" magazine:

1. Learn with the Students

Don't feel like you need to be a "walking encyclopedia" of facts to lead a good field trip. How you react to something speaks so loudly that often people don't hear what you are saying. Be an enthusiastic facilitator rather than a boring lecturer. Don't be afraid to say, "I don't know but let's find out."

2. Reinforce Discovery

When a child brings you a snail, insect, worm or crab, this is the most important thing in the world to him or her. Respond with enthusiasm to this discovery and call the group together if possible to share what has been found. Hopefully your own discoveries will excite you; share it! Enthusiasm is a greater catalyst than knowing a bunch of names.

3. Use Questioning Skills

Discussions are better than lectures at invoking participation and involvement from a group. Open-ended, stimulating questions encourage thinking. "Why is this animal living here?" "What would you need to live in this place?" "Does this animal have anything that helps it live here?" These are examples of questions that promote thinking and group interaction.

4. Label Last

We are a culture of labelers. Often, once we know the name of something we turn off our attention, put it in its neat little box and search for something else to label. Names are good to know but so is information on what something is, why it does things and other factual information.

5. Ouch! Ouch! Ouch!

Be the voice of the plants and animals when students, in their eagerness, get careless. Try to impart an ethic without a negative tirade.

We're glad you're interested in exploring with us.

adaptable: Able to adjust to a situation.

algae: Seaweeds.

community: The populations inhabiting an area and interacting with one another.

consumer: An organism that eats plants or other animals.

decomposer: An organism that breaks down dead materials such as leaves and animals.

* **detritus** (dee-TRY-tus): Decaying bits of plants and animals.

diatoms: A type of single-celled phytoplankton.

ecology: The study of the relationship between living things and their environment.

energy: Strength to move and grow.

* **estuary** (ES-choo-ary): A place where fresh water mixes with salty sea water.

filter feeder: An animal, such as a clam or oyster, that filters food from the water.

* **food chain**: The chain of what eats what.
* **food web**: Overlapping and connecting food chains.
* **habitat**: The place where a plant or animal lives.

invertebrate: An animal without a backbone.

marine: Having to do with sea water.

migration: The seasonal movement from one place to another.

organism: A living thing.

photosynthesis: When plants use sunlight to change carbon dioxide and water into food.

* **phytoplankton**: Free-floating microscopic plants.
* **plankton**: Tiny plants and animals that float freely in water.

predator: An animal which captures and feeds on other animals.

prey: An animal that is hunted by another for food.

producer: Something that makes its own food, such as a plant.

salt marsh: Grassy wetland bordering an estuary.

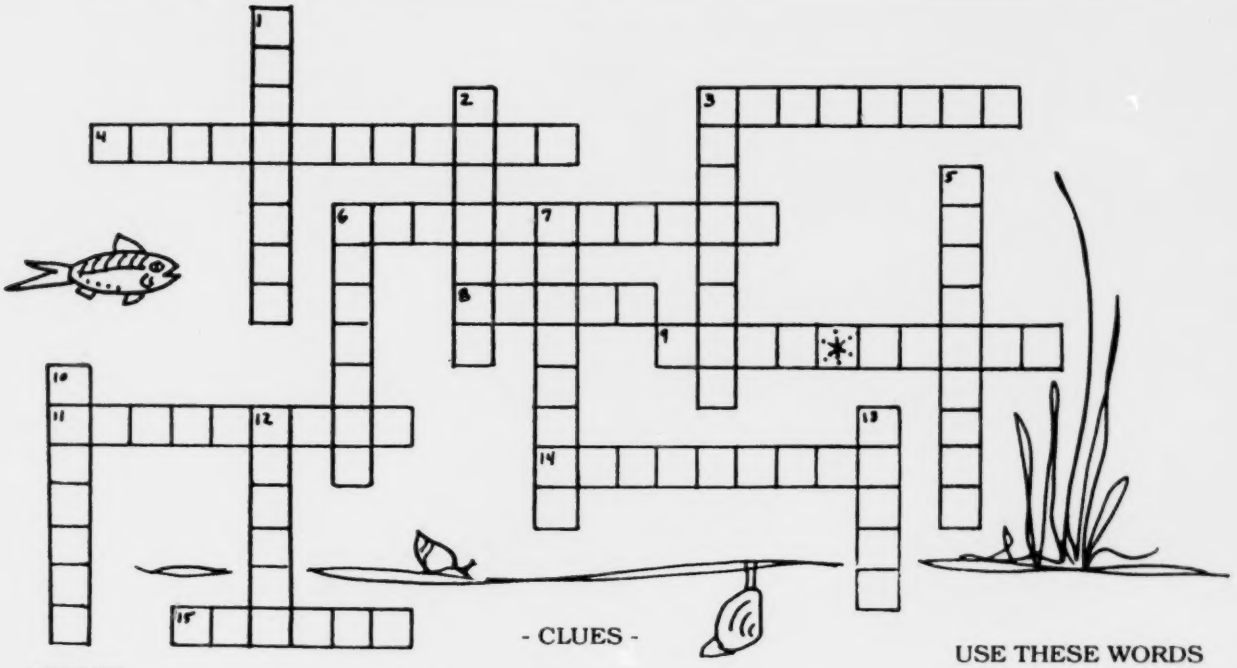
scavenger: An animal that eats anything; a collector.

wetlands: A lowland area, at times covered by water.

wrack: A tangled mass of seaweeds and organisms washed ashore.

* **zooplankton** (ZOH-plankton): Free-floating microscopic animals.

* Key Vocabulary



- CLUES -

ACROSS

3. something that makes its own food, like a plant.
4. an animal without a backbone.
6. the world around us.
8. seaweeds
9. the "chain" of what eats what.
11. animals that eat other plants and animals.
14. an animal, like a crab, that eats anything.
15. strength to move and grow.

DOWN

1. bits of dead plants and animals.
2. the place where an animal or plant is found.
3. tiny organisms that float freely in the water.
5. the seasonal movement from one place to another.
6. a place where fresh river water mixes with salty sea water.
7. a living thing.
10. the relationship between living things and their environment.
12. having to do with salt water.
13. the tangled mass of seaweeds and organisms washed ashore.

USE THESE WORDS

algae
consumers
detritus
ecology
energy
environment
estuary
food chain
habitat
invertebrate
marine
migration
organism
plankton
producer
scavenger
wrack

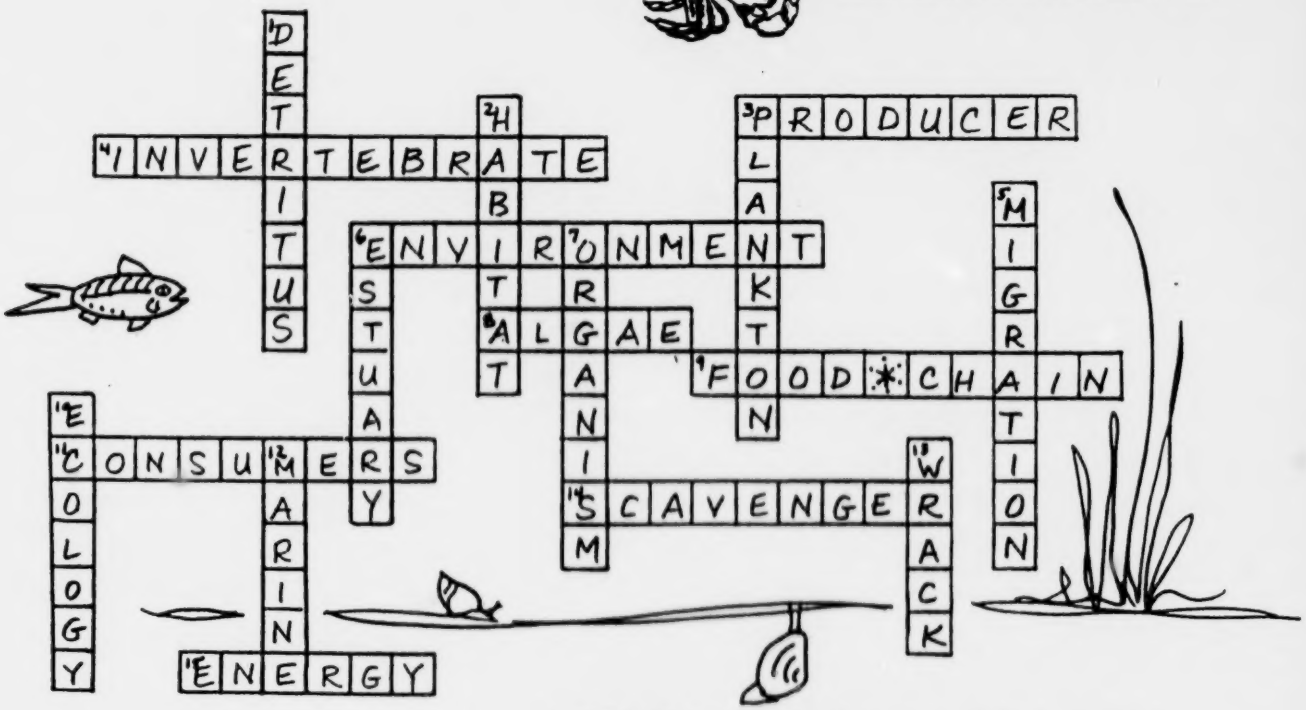
Find the 18 Vocabulary Words Below:

A D L M S L I R Y L J R D U L S R W
L E C O L O G Y S E N I R A M Y R V
O T E T E J D I I D N O C C A S S A
S R N A M U E O S Y S T R C R P L S
H I C J D E C O M P O S E R A A E M
O T I S D G E K E E T D S A R A V U
O U A N S O N P L A D E T I E A U A
T S R O V E V L N I K A U T E A R S
N S R E N E I L N E I K A C A S W C
S O N B C S R Y I X V Q R C N R W A
I E U C T T O T O M U D Y R Y J G V
S U W A Y Z N D E I S I E U I F I J
E S R D O W M E E B V T R S F I J N
H B A L G A E T I I R C E T C A B G
T N C N U I N I R W A A U A Y D X E
N M K W S T T O E T S C T N A A R W
Y C S K T T K D Y N T U H E B P C S
S E T I E C I B O C E A N U A T I P
O E R H N U E R R Q U C E N C A E L
T I E P K A K E I U O X O B Q B R H
O G A C D O G A L N O T K N A L P Y
H L A U G H P R Y G O T L O C E J O
P Z T I R T E D O K G N I W H W P B

Vocabulary Words:

ADAPTABLE
ALGAE
DECAY
DECOMPOSER
DETRITUS
ECOLOGY
ENVIRONMENT
ESTUARY
INVERTEBRATE
MARINE
MUD
OCEAN
ORGANISM
PHOTOSYNTHESIS
PLANKTON
PREY
WING
WRACK

CROSSWORD PUZZLE KEY



WORD SEARCH KEY

A	D	L	M	S	L	I	R	Y	L	J	R	D	U	L	S	R	W
L	E	C	O	L	O	G	Y	S	E	N	I	R	A	M	Y	R	V
O	T	E	T	E	J	D	I	I	D	N	O	C	C	A	S	S	A
S	R	N	A	M	U	E	O	S	Y	S	T	R	C	R	P	L	S
H	I	C	J	D	E	C	O	M	P	O	S	E	R	A	A	E	M
O	T	I	S	D	G	E	K	E	E	T	D	S	A	R	A	V	U
O	U	A	N	S	O	N	P	L	A	D	E	T	I	E	A	U	A
T	S	R	O	V	E	V	L	N	I	K	A	U	T	E	A	R	S
N	S	R	E	N	E	I	L	N	E	I	K	A	C	A	S	W	C
S	O	N	B	C	S	R	Y	I	X	V	Q	R	C	N	R	W	A
I	E	U	C	T	T	O	T	O	M	U	D	Y	R	Y	J	G	V
S	U	W	A	Y	Z	N	D	E	I	S	I	E	U	I	F	I	J
E	S	R	D	O	W	M	E	E	B	V	T	R	S	F	I	J	N
H	B	A	L	G	A	E	T	I	I	R	C	E	T	C	A	B	G
T	N	C	N	U	I	N	I	R	W	A	A	U	A	Y	D	X	E
N	M	K	W	S	T	T	O	E	T	S	C	T	N	A	A	R	W
Y	C	S	K	T	T	K	D	Y	N	T	U	H	E	B	P	C	S
S	E	T	I	E	C	I	B	O	C	E	A	N	U	A	T	I	P
O	E	R	H	N	U	E	R	R	Q	U	C	E	N	C	A	E	L
T	I	E	P	K	A	K	E	I	U	O	X	O	B	Q	B	R	H
O	G	A	C	D	O	G	A	L	N	O	T	K	N	A	L	P	Y
H	L	A	U	G	H	P	R	Y	G	O	T	L	O	C	E	J	O
P	Z	T	I	R	T	E	D	O	K	G	N	I	W	H	W	P	B

A Bit About Estuaries...

The Skagit River begins in the North Cascade Mountains. It tumbles down mountainsides, spills over waterfalls, runs past towns and under bridges, and winds through rich farmland. It finally slows down as it nears the sea. An estuary: the place where a river meets the sea.

Estuaries are amazing places. Many plants and animals live here, where the fresh water from the river mixes with the salty ocean water. These plants and animals are all connected to each other. They depend on each other for food and shelter.

Questions:

1. What is an estuary?

2. How are the plants and animals in an estuary connected to each other?

Plants

An estuary food web begins with the sun. The sun's energy warms up the shallow water and is captured by the many kinds of estuary plants. Phytoplankton are the tiny, free-floating plants. They are too small to see but are very important as food for small animals. Another kind of plant is eelgrass, which grows tall and thin. It covers Padilla Bay like a green forest and is home to many animals that live on its

blades. At the edge of the water grow salt marsh plants which live with their feet in salt water and their leaves in the air. A fourth type of plant is seaweed. Seaweeds are large algae (pronounced AL-jee). Some are green, some are brown and some are red. Together, these plants turn sunlight energy into food for all of the animals living in the estuary.

Questions:

1. Name 4 kinds of estuary plants.

2. Where do plants get their energy?

3. What gets energy from the plants?

Animals

An estuary is important to animals for many reasons. It can be a home, a rest stop or a nursery.

Oysters, for example, spend their whole lives in an estuary. They begin as free-floating zooplankton (tiny animals) and then settle onto rocks or shells as they mature.

Salmon need to stop in an estuary on their journey from the river to the sea. The bay provides food, shelter, and a place for the young salmon to adjust to the salty ocean water.

Thousands of birds also stop at estuaries on their long trip between north and south. There is a lot of food for them in the estuary. Some stay and spend the winter, while others just rest for a time and move on.

Many animals use the estuary as a nursery for raising their young. Baby Dungeness crabs can hide from predators in the eelgrass meadows until they are old enough to move to deeper water. Harbor seal pups can grow up safely in the protected bay. Most marine animals are somehow connected to an estuary.

Questions:

1. Name an animal that uses an estuary as a home.

2. Name an animal that uses an estuary as a nursery.

3. Name an animal that uses an estuary as a rest stop.

People

People are connected to estuaries, too. Estuaries provide a lot of food for us to eat. People like to live near estuaries because they are beautiful places, with fun thing to do like boating and fishing.

Most people in our country live on the east or west coast, near an estuary. Many of the world's largest cities are built on estuaries. An estuary is a good place for a city because it has many things that a city needs. The river supplies fresh water for drinking and hydro-electric power. The flat land by the river is rich farmland. The protected bay is a safe harbor for boats. Goods can be transported in and out by river and

ocean, making the estuary an excellent site for factories and businesses.

An estuary may be a good place for a city, but it is also a bad place for a city. Because so many people now live near estuaries, estuaries are in trouble. People have polluted the estuary water, not knowing how valuable an estuary is. They have filled in the shallow areas for factories and houses. They have drained the mudflats for farming. They have dredged (dug out) channels and harbors for large boats. Seattle is a good example of a city built on what was once a natural estuary.

If we don't take better care of important places like estuaries, we will lose many plants and animals that we enjoy and depend on. Imagine a world without crabs, salmon, clams, oysters, shrimp, and other marine life. By learning more about estuaries, you will be able to help us take better care of them.

Questions:

1. Name 3 reasons that people live near estuaries.

2. Name 3 ways people have abused estuaries.

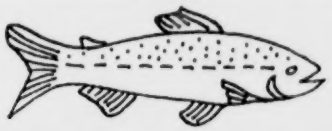
BONUS: What can you do to help take better care of estuaries?

A "FOOD CHAIN" CHAIN

Food chains are sometimes hard to picture. Let's use the strip drawings below to make our own food chain.

SHRIMP

SALMON



ZOOPLANKTON

PHYTOPLANKTON

EAGLE

1. Color the primary producer green. Where does the primary producer get its food?

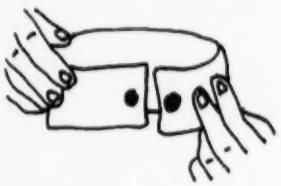
2. Which animals are consumers? What do they eat?

3. Which of these animals and plants could we eat?

4.a. Obtain a pair of scissors and a stapler or paste.

b. Cut out the strips on the solid lines.

c. Find the strip that shows the primary producer. Match the dots on it to make one link. Staple or paste the link at the dots.



d. Now add the link showing the animal that would eat the primary producer.

e. Keep adding links. Stop when you have a chain with five links. Be sure your links are in the correct order.

5. Now you have a single chain. Imagine that pollution kills all of the shrimp.
   How many chains would you have left?
   Would both parts of the chain be able to survive?
   If not, which organisms (plants and animals) would be able to survive?
   List them here:

6.a. Obtain a strip the same size as your other links.
   b. Draw the sun on the strip.
   c. Write the word "SUN" on the strip.
   d. Add the sun strip to your chain in the correct place. The sun is the source of energy for all living things.
   e. What would happen to your chain if the sun disappeared?

7.a. People can eat several of the animals shown on our links. Obtain several blank strips.
   b. Write "PERSON" on the strips.
   c. Add your new "PERSON" links wherever they make sense.

8.a. Adding the "PERSON" changes your food chain into a food web. Obtain several more blank strips.

b. Look at your links. Think about who might eat some of the organisms. Write the names of these new animals on your blank strips.

c. Add the new strips to your food web.

9. Put your name on your food web. Display it proudly!

adapted from Poulsbo Marine Science Center FOR SEA curricula, grade 4

ESTUARY SEARCH

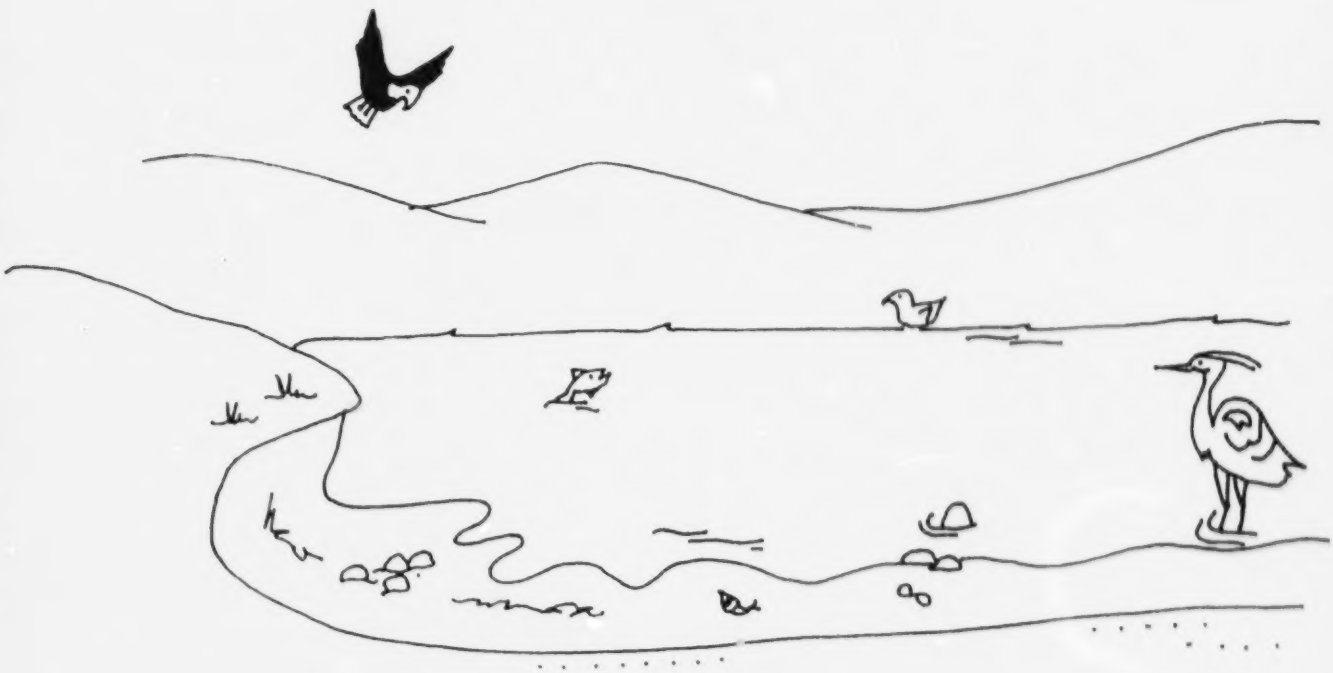
You will need blue, green, red and regular-leaded pencils.

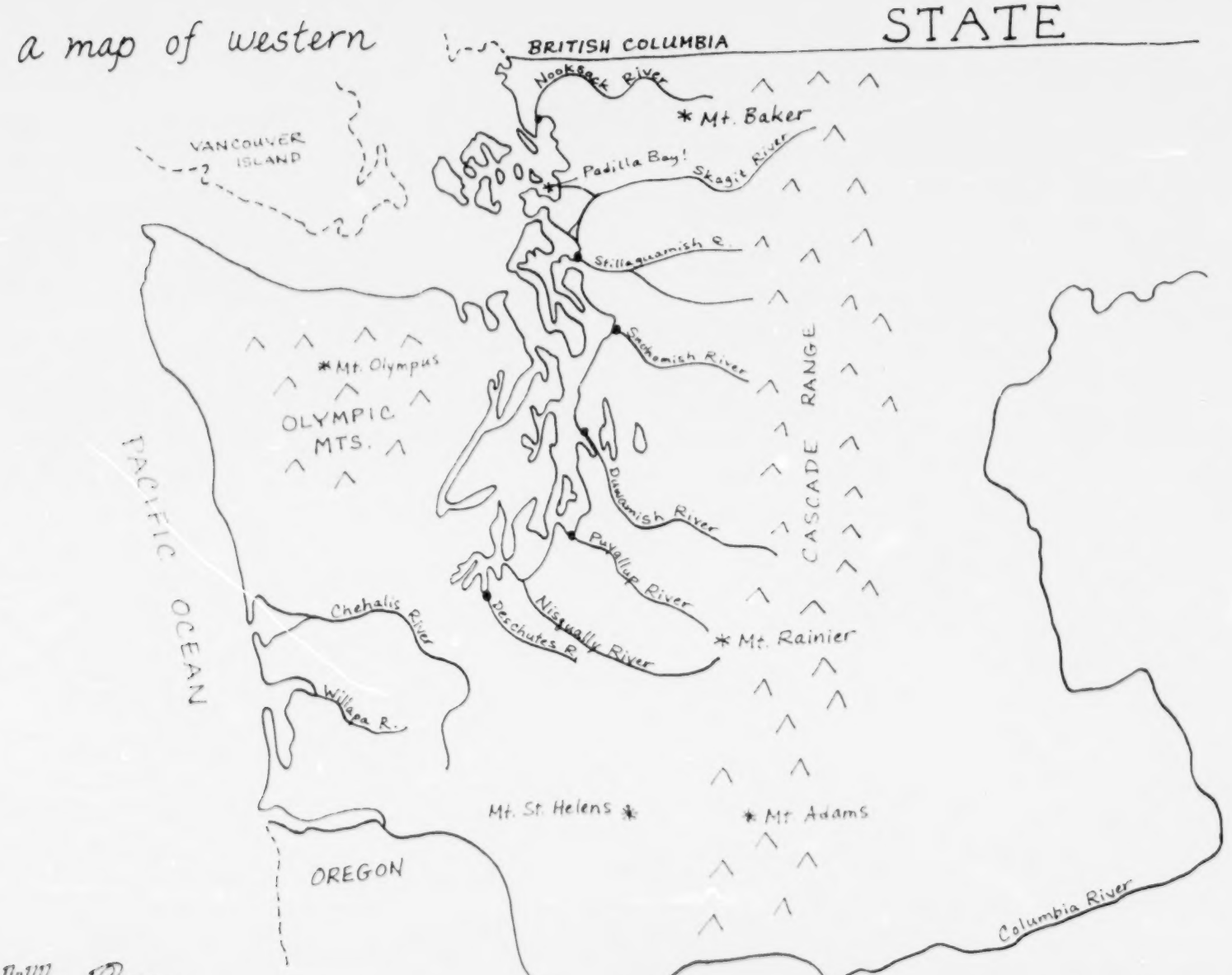
1. What is the name of your state?_____
   Using a regular pencil, write it on the map.
2. What is the name of your city?_____
   Locate it on the map and write it in with your pencil.
3. Find the river nearest to where you live. Find the mountains from where it begins. What are these mountains called? _____
   _____
4. In BLUE, trace the path of this river from its source to where it meets the sea.
5. With a GREEN pencil, color in the salt water near the mouth of that river.
6. In RED, circle where the freshwater river meets and mixes with the salt water from the ocean. This place is called an estuary.
7. Find these rivers and trace their paths using BLUE: Nooksack, Skagit, Stillaguamish, Snohomish, Duwamish, Puyallup, Nisqually, Deschutes, Chehalis, Willapa, Columbia.
8. In RED, circle the estuaries where these rivers meet the salt water.
9. Label the following cities with your regular pencil: Olympia, Tacoma, Seattle, Everett, Stanwood, Mt. Vernon, and Bellingham.
10. How many of these cities are near an estuary?

As you may have noticed, many cities in Washington are built near an estuary. This is also true for most of the largest cities in the world. We are beginning to learn that estuaries are some of the richest places on earth.

Padilla Bay is such a place. Come and discover the treasures that are hidden in the estuary.

adapted from South Slough National Estuarine Research Reserve





Padilla Bay

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Magazines

"Clearing: Nature and Learning in the Pacific Northwest"
Environmental Education Project
P.O. Box 751
Portland, OR 97207
- A valuable network of people and places, information on "happenings", ideas, activities, and resources for teaching about the environment.

"Naturescope", "Ranger Rick", "National Wildlife", International Wildlife"
National Wildlife Federation
1412 Sixteenth Street, N.W.
Washington, D.C. 20036-3366
-Exemplary publications for all ages; excellent photography.

Reference Books

Angell, Tony and Kenneth C. Balcomb III, ***Marine Birds and Mammals of Puget Sound***, Seattle: Puget Sound Books, 1982.

Berrill, J.J. and Jacquelyn, ***1001 Questions Answered About the Seashore***, New York: Dover Publications, 1957.

Coulombe, Deborah, ***The Seaside Naturalist***, New Jersey: Prentice-Hall, Inc., 1984.

Flora, Charles and Eugene Fairbanks, M.D., ***The Sound and the Sea***, Bellingham, WA: Western Washington Press, 1982.

Harbo, Rick, ***Tidepool and Reef***, Vancouver, B.C.: Hancock House Publications Ltd., 1980.

Holling, H. Clancy, ***Pagoo***, Boston: Houghton Mifflin Co., 1957.

Kozloff, Eugene, ***Seashore Life of the Northern Pacific Coast***, Seattle, WA: University of Washington Press, 1983.

Snively, Gloria, ***Exploring the Seashore of British Columbia, Washington and Oregon***, Vancouver, B.C.: Gordon Soules Book Publishers Ltd., 1978.

Yates, Steve, ***Marine Wildlife of Puget Sound, the San Juans, and the Strait of Georgia***, Connecticut: The Globe Pequot Press, 1988.

Zim, Herbert and Lester Ingle, ***Seashores: A Guide to Animals and Plants Along the Beaches***, New York: Golden Guide Press, 1955.

Resources

(Reference Books, continued...)

Curricula

Alaska Sea Week Curriculum Series

Alaska Sea Grant College Program
University of Alaska
Fairbanks, AK 90701

- A wonderful series of interdisciplinary beach and classroom activities in all aspects of marine studies, for elementary grades; award winner.

Aquatic Project Wild

Project Wild Coordinator
Washington State Department of Wildlife
16018 Mill Creek
Mill Creek, WA 98012
(206)775-1311

- A compilation of diverse, interdisciplinary activities for all ages. Available through teacher workshops only.

Coastal Zone Studies

Washington State Office of Environmental Education
17011 Meridian Avenue North #16
Seattle, WA 98133-5531

- In-depth junior and senior high school curriculum for studying coastal areas, including estuaries.

Discover Wetlands

Washington State Department of Ecology
Wetlands Section, Mail Stop PV-11
Olympia, WA 98504

- A collection of information and activities focusing on wetlands in Washington State for grades 4-8.

The Estuary Book and others

Western Education Development Group
University of British Columbia
Vancouver, B.C. CANADA V6T 1W5

- This is one of a series of booklets on various water habitats, with information and activities geared for older students.

(Curricula continued...)

The Estuary Study Program

South Slough National Estuarine Research Reserve
P.O. Box 5417
Charleston, OR 97402
- An imaginative on-site program for upper elementary and junior high school plus classroom activities for senior high school.

Hanging on to Wetlands

Irwin Slesnick
Biology Department
Western Washington University
Bellingham, WA 98225
- Interdisciplinary classroom and field activities for studying wetlands.

OBIS: Outdoor Biology Instructional Strategies

Delta Education, Inc.
Box M
Nashua, NH 03061-6012
- Creative and active ideas in environmental education, marine studies included; for all ages.

ORCA: Ocean Related Curriculum Activities

Marine Education Project
Pacific Science Center
200 Second Avenue North
Seattle, Wa 98109
- "High Tide, Low Tide" and "Life Cycle of the Salmon" for grades 3-4, can be adapted for lower grades; excellent information and activities; clear format.

Project for Sea

Marine Science Center
17771 Fjord Drive N.E.
Poulsbo, WA 98370
- Extensive and exemplary curriculum for grades 2nd and 4th (older available as well); content includes animal and plant identification and ecological concepts; award winner.

Resources

(Curricula continued...)

The Seattle Aquarium Curriculum

The Seattle Aquarium
Pier 59, Waterfront Park
Seattle, WA 98101
- Curriculum for all grades, preschool as well, to supplement visits to the Aquarium; teacher information, pre- and post-visit activities included.

Places

Bellingham Maritime Heritage Center

1600 "C" Street
Bellingham, WA 98225
(206)676-6806
- Salmon hatchery; education programs available.

Discovery Park

3801 West Government Way
Seattle, WA 98199
(206)386-4236
- Extensive urban park with a variety of shoreline habitats.

Point Defiance Zoo & Aquarium

5400 North Pearl Street
Tacoma, WA 98407
(206)591-5335
- An exemplary zoo with aquariums; education programs available.

Port Townsend Marine Science Center

Fort Worden State Park
Port Townsend, WA 98368
(206)385-5582
- Touch tanks, education programs available.

Poulsbo Marine Science Center

17771 Fjord Drive N.E.
Poulsbo, WA 98370
(206)779-5549
- Marine center with comprehensive school programs.

(Places continued...)

The Seattle Aquarium

Pier 59, Waterfront Park
Seattle, WA 98101
(206)625-4358
- Extensive aquariums and exhibits; school programs.

The Whale Museum

P.O. Box 945
Friday Harbor, WA 98250
(206)378-4710
- Museum and research dedicated to whales; curriculum for elementary grades.

Washington State Office of Environmental Education

17011 Meridian Avenue North #16
Seattle, WA 98133-5531
(206)542-7671
- A resource center for environmental educators; offers curriculum materials, films, videos and teacher workshops.

Organizations

Northwest Association of Marine Educators (NAME)

Karen Mattick, Sec/Treas
Marine Science Center
17771 Fjord Drive N.E.
Poulsbo, WA 98370
(206)779-5549
- An active organization of educators and enthusiasts interested in marine and aquatic education; NAME is the regional chapter of the National Marine Education Association (NMEA).

The day's program is packed with a variety of activities, flexible enough to work within your time limitations. There may be optional activities; we reserve the right to make changes in response to unforeseen events. Our goal is to make the day meaningful to you; it will be most successful if we can complement your curriculum.

Following is a typical time schedule. We need at least four hours to successfully carry out this program. Some of the on-site activities are included. All on-site materials will be supplied by us for your use.

The Estuary Program - Level 2 Schedule

This is an on-site program that includes important pre-trip materials and various post-trip ideas for use by the teacher in preparing for a visit to the Reserve. This time plan can be adapted to individual needs and schedules.

9:30 - 10:15 - Welcome and Orientation

The group will meet in the theater for an introduction to Padilla Bay. Terms such as "estuary", "plankton" and "detritus" will be explained through a film and a short skit by the "Estuary Soup" chef.

10:30 - 11:30 - Mudflat Safari

The class will head down to the water's edge. Teams of 6-8 students, each with an adult leader, will explore the different habitats of the estuary by completing a scavenger hunt. The class will then regroup to discuss the morning's findings and take note of other characteristics of estuaries.

11:30 - 12:00 - Lunch at Bayview State Park

12:15 - 12:30 - Water Drop Jungle: Plankton Viewing

Differences between phytoplankton (plants) and zooplankton (animals), and temporary and permanent plankton will be discussed. The live plankton sample gathered at the beach will be projected onto a screen for all to view.

12:30 - 1:00 - Interpretive Exhibits

This time is set aside for students to take in the exhibits at the Center. There are displays depicting habitats in Padilla Bay, a "hands-on" room set up for children of all ages, microscopes for individual use, and live saltwater aquaria. A list of questions pertaining to the aquaria is included on pages 21-22, for use by adult leaders to help focus attention.

1:00 - 1:45 - Human History of the Bay

After a "chalk talk" of past uses and abuses of estuaries, the class will recreate a true-to-life "Padilla Bay Town Council Meeting". Students will role play community members with differing viewpoints and then vote on the future of Padilla Bay.

1:45 - 2:00 - Wrap Up

Key concepts will be summarized. "Certificates of Understanding" will be handed to each participant.

Padilla Bay's SCAVENGER HUNT

☐ Clamshells: One with ridges ☐

...and one without ☐

☐ 4 different kinds of birds:

☐_____ ☐_____ ☐_____ ☐_____

☐ An animal carrying its home on its back.

☐ 3 different marine plants. 1.☐ 2.☐ 3.☐

☐ An animal track.

☐ Something that changes._____

☐ Something that never changes._____

☐ 2 kinds of crabs. ☐_____ &☐_____

☐ 3 unique smells.

1._____ 2._____ 3._____

☐ 2 different mud dwellers. 1._____ &

2._____

☐ Signs of human influence. 1._____

2._____ 3._____ 4. garbage

*Please return **all** critters to their homes when you're done.*

Padilla Bay Town Council Meeting: Simulation Game

Introduction

People have always been attracted to estuaries, and for good reason. There are a lot of edible food resources (clams, oysters, crabs, fishes, ducks and geese, shrimp, etc.) and rich, flat farmland nearby. Industry, too, finds estuaries good sites for development because they are easy to get to by way of rivers, oceans, trucks or trains. Bays are attractive for swimming and sailing; often there are beaches for picnicking. Estuaries are beautiful, peaceful places.

As more people move into an area more houses, stores, marinas and factories are needed. Padilla Bay is no exception, and in the early 1960s, the little town of Bay View was faced with a major decision: what should happen to Padilla Bay?

Where would you stand in this debate:

1. Would you allow Padilla Bay to be developed? OR
2. Would you preserve Padilla Bay in its natural state? OR
3. Would you compromise — limit some uses but allow others?

Padilla Bay Town Council Meeting: Simulation Game

Directions

Each group will receive an envelope with a pencil, a blank character sketch sheet, and a card describing a specific character.

1. For this game, you need to erase who you are in real life and become this character.
2. Create your character. Who are you? What do you do? Why are you interested in what happens to the bay? Make yourself as believable as possible.
3. As a group, decide what you (your character) believe should happen to Padilla Bay. Should it be developed, preserved in its natural state, or do you feel a compromise would be best? Write down 2 or 3 good, convincing reasons why you feel that way.

We will hold a "Padilla Bay Town Council Meeting" and give one spokesperson from each group a chance to express the group's opinion. Through open debate and a town vote we will decide the future of the bay.

Padilla Bay Town Council Meeting

Character Sketch

My name is _____

I am (what do you do?)_____

_____

_____

_____

I would like to (circle one):

...preserve...develop...find a compromise for...

Padilla Bay because _____

_____

_____

and_____

_____

_____

_____

_____

Padilla Bay's Town Council Meeting: Simulation Game

Position Briefs

Pro-development:

Representative from O.I.L. Corporation **Will/Willma Dredge**

You are considering the estuary as a place to develop your oil industry. You know that it is easy to get to by tankers, trains and trucks, and since it looks empty, you don't see any problems.

Unemployed Carpenter **Tom/Thomasina Sawyer**

You're a carpenter by trade, but have been doing only "odd" jobs for the past few years. You've got a growing family to feed, and are concerned about making ends meet. You're all for building marinas or condominiums in Padilla Bay — anything that will insure steady employment.

City Planner **Bill/Belle Dupp**

You think people would love to live on Padilla Bay. You propose to fill in parts of the bay to build condominiums.

Marina Developer **Chris Craft**

You know that there are many people who are looking for a marina to keep their boat. Padilla Bay looks like the perfect place to build.

Pro "Keeping it Natural", Creating a "Preserve":

Tourist **Nat Tural**

You value beauty and quiet, and would like to see future generations have a chance to see "untouched" places like Padilla Bay.

Long-time Resident **Leevus A. Lone**

You live on Padilla Bay and enjoy its peaceful environment. You'd like to see the bay remain the same as it was when your family first settled here.

University Professor **Dr. C. Chowder**

You specialize in shellfish and want to make sure that the bay has lots of them. You know that healthy shellfish need a healthy environment.

Member of the Audubon Society **Robin Thrush**

Over 200 species of birds migrate through Padilla Bay. You spend much of your time watching these birds, and care deeply about their fate. You know how important Padilla Bay is for migrating birds, as well as for the endangered Peregrine Falcon and the Bald Eagle.

Pro Compromise:

Mayor of Padilla Bay **"Skipper Waterson"**

You love the open water and feel that boating is a great form of recreation. Marinas are important, as is a quiet place to sail. Election time is nearing.

Native American Fisherman **Anito/Anita Fish**

You catch salmon for a living; salmon need estuaries to survive. You want to guarantee that your children will be able to make their living by fishing, as you do now.

Member of "Duck Hunters United" **Joe/Josie Mallard**

You really enjoy hunting and want to keep the bay open to hunters. You want to be sure that there will be enough ducks for future generations to also have the opportunity to experience the satisfaction of gathering their own food.

Store Owner **Rod/Annette Forsale**

You live by Padilla Bay and own a sporting goods store. You sell fishing and hunting supplies.

The following is a compilation of interdisciplinary activities grouped by content areas. Some are "trigger" ideas, other are more involved projects. Starred (*) ideas are attached.

We would be delighted to hear which ones worked and which ones didn't, and why. Any suggestions are always welcomed. Our hope is that the experience of the day will not end when you leave Padilla Bay.

(starred (*) ideas are included in this guide)

Language Arts

- write poetry, haiku, or other forms of expression on what an estuary means to you.
- make up riddles or limericks describing "sea treasures"; have others guess.
- describe a day in the life of a young salmon who has journeyed downstream to the estuary. What kinds of plants and animals do you see? Where do you like to hide? What do you eat? What are you afraid of? How is life different here than it was upriver? What will it be like in the ocean?
- for each letter in ESTUARY, have the children write a word or phrase describing such a place.
- play password with the new estuary vocabulary words.
- write a letter to the Padilla Bay educators about your field trip and what you experienced there.
- write myths on why the sea is salty.
* write a story to explain the untitled drawing (page 79).
* talk about the origin of words and fill in the "Word Roots" sheet (page 81).
* have your students publish an Estuary Edition of "The Wetlands Gazette" (page 85).

Social Studies

- describe the life of a Native American child living by Padilla Bay.
- as early explorers, write a letter back to Europe explaining why or why not Padilla Bay would be a good place to settle.
- interview older local folks for memories of "before".
- write laws for governing an estuary and vote on them.
- invite your state representative to speak to your class on an environmental issue affecting your community.

Interdisciplinary Activities

- look at maps of the country and world. Locate major rivers and their estuaries. How many cities can you find that are built on estuaries?
* work through the "Recreational Uses of Padilla Bay" activity on the economic value of estuaries (page 89).
* carry out the "Marsh to Marina" activity (page 91).
* read both newspaper editorials in "The Value of Wetlands" and discuss the different attitudes (pages 97-101).

Math

- find the actual size of microscopic animals using microscopes and graph paper.
- solve mathematical problems dealing with numbers of organisms in a food chain.

Science

- learn the taxonomic classification system for marine organisms.
- make and use a dichotomous key for clamshells.
- talk of research: What do we want to learn about estuaries and why do we want to know it? How could we go about researching it?
- learn about tides and how to read a tide table.
- pin the name or picture of an estuary animal on a student's back and have him/her guess what it is by asking only yes-no questions.
- observe and compare differences between fresh and salt water; boil the water out of a flask containing salt water and see what is left behind.
* complete the "Whiz Quiz!" on estuaries (page 103).
* do the "Let's Find Nature's Garbage Can" activity and discuss recycling (page 105).
* use "The Padilla Bay Environment" sheet to study which habitats support which animals (page 109).
* piece together the "Looking into an Estuary" activity (pages 111-113).
* play the "Food Chain Game" (pages 115-117).

Physical Education

- visit places like the Nisqually Wildlife Refuge and the Skagit Recreation Area (near Conway) and take a walk.
- play charades: act out how animals move and eat.
- demonstrate a "food chain in action" as a group effort (seastar eating a clam, heron spearing a fish, a large anemone filter feeding, etc.).
- tell a story about the estuary without words.
- have one student be the sun and ask each in turn to add a link to the "food chain".

Creative Thinking

- design mud shoes (think of snow shoes)
- study why animals become endangered and what, if anything, we should do about it.
- discuss ways each of us can improve our natural environment. Talk of inspirational people who have affected changes in their community (Edna Breazeale, for example).
- set up a debate between two groups with opposing viewpoints on preservation and the progress of civilization.
- why do we have National Estuarine Research Reserves? Are they important? Why?
- discuss why few natural estuaries remain.
* try the "Human Uses of an Estuary" activity (page 119).
* make an estuary "3-D Board" (page 123).

Art

- draw a mural of a beach scene and have each student add to it, filling in the picture.
- try Gyotaku: fish printing. Compare a flounder to a salmon.
- make clam shell rubbings and note difference in shells.
- become "scavengers" and make mobiles out of beach wrack.

POST TRIP IDEAS

Interdisciplinary Activities

- use the shapes of plankton as part of a painting.
- make plaster castings of shells.
- create a "photo essay" of a day in an estuary.
- draw a comic strip about a hermit crab.
* try a "Fun Page" (page 131).
* read the "Afternoon in an Estuary" drawing activity (page 133).
* have each of your students make an "amazing facts" box (page 135).
* have students research and sculpt their plant or animal in "Critter Creations" (page 137).

Music

- make a "sound collage" of an estuary.
- try to imitate bird songs, animal calls; tape yourself.
- make a reed flute, clamshell chimes.
- play music that reminds you of water.
- sing sea chanties.
* sing "The Estuary Food Chain Song" (page 139).

Health

- what would early settlers have eaten? How has that changed? Compare our menu to theirs for food sources and nutritive value.
- talk to a Japanese chef about the nutritive value of seaweed and cook some up.
- prepare a menu for breakfast, lunch and dinner using food from the estuary: a seafood feast!
- make a list of products using algin and carrageenan: derivatives from seaweed.
- talk to a dentist about uses of barnacle "glue" in dentistry!

What's happening here?

Use your imagination. Look at the picture below and write a story describing what is going on here. Don't forget a title for your story.

Thanks to the Poulsbo Marine Science Center

WORD ROOTS

Latin and Greek are a very important base for much of our English language. Many scientific terms are derived from these roots. Write some examples of words which contain these roots or prefixes.

1. aqua (water)_____
2. mar, mare (sea)_____
3. hydro (water)_____
4. therm (heat)_____
5. eco (home)_____
6. bio (life)_____
7. nav (ship)_____
8. scop, scope (see)_____
9. mini, minu, micro (small)_____
10. -ography, -ology (study of)_____
11. photo (light)_____
12. zoo (animal)_____

Adapted from the National Aquarium in Baltimore Curriculum

Word Roots

1. **aqua** (water): aquatic, aquarium, aqualung, Aquarius, aqueous, aqua-marine
2. **mar, mare** (sea): marine, maritime, marina, mariner, Marine Corps
3. **hydro** (water): hydrant, hydrogen, dehydrate, hydroelectric, hydrology, hydrosphere
4. **therm** (heat): thermometer, thermos, thermal, thermostat
5. **eco** (home): ecology, ecosystem, ecotype, ecosphere
6. **bio** (life): biology, bionic, biography, biopsy, biochemistry, biosphere
7. **nav** (ship): navigation, circumnavigate, naval, Navy
8. **scop, scope** (see): telescope, microscopic, scope
9. **mini, minu, micro** (small): miniature, microscope, minimal, microbiology, minute, minus
10. **-ography, -ology** (study of): geology, photography, zoology, biology, oceanography
11. **photo** (light): photosynthesis, photography, photocopy, photic, photo finish
12. **zoo** (animal): zoo, zoology, zooplankton, zoological

Adapted from the National Aquarium in Baltimore Curriculum

THE WETLANDS GAZETTE "Estuary Edition"
A Student Newspaper

Purpose: To increase student awareness of the importance of estuaries and related wetlands, the uses and abuses of these environments, and the local and regional issues surrounding wetlands.

Introduction: Wetlands are all around us. Bays and estuaries, salt and fresh water marshes, rocky intertidal areas, swamps and bogs are all fragile wetlands that need our understanding and attention — before it's too late. But we often think of them as being in someone else's backyard.

This activity will highlight the importance of wetlands, especially estuaries, in our daily lives. One need only pick up a copy of a newspaper to see how many businesses, recreational activities, environmental concerns and management issues are dependent on these environments.

Students will draw from their studies as well as from their lives and local environments to gather information. They will then compile it into a creative, share-able product.

Directions: Explain to your class that they are going to write, print and circulate a newspaper, "The Wetlands Gazette", Estuary Edition. Discuss the need for various departments to be formed in order to produce a newspaper about wetlands and ask for suggestions (i.e. local, regional and national news, editorials, sports and recreation, etc.).

Study the local newspaper with the group. You might also arrange to take a trip to a newspaper office or invite a news media representative to speak to your students. This will allow them to see how complex the news-gathering

process is. If your school has its own newspaper, consult with the staff for resources and advice, or invite the staff to work with you to produce your "Gazette".

Organize students into four or more news departments. Ask each department to discuss types of stories and headlines they can write. Examples of departments and sample topics are listed on the following page. Illustrations or photographs should accompany the stories.

Proceed with newspaper production. Duplicate the students' work and let the class put the newspaper together.

The circulation department from the group should develop a plan to distribute the newspaper locally in school and perhaps also in the community. Contact the local newspaper to see if the editor will print one or two of the better stories.

Finally, review the newspaper with the students. Question them about wetland values and issues. What have they learned about natural resource management? What are some of the issues surrounding wetlands in their communities? What have they learned about publishing a newspaper? What was the biggest problem they encountered and how did they solve that problem?

Adapted from Wetlands Conservation and Use
U.S. Fish & Wildlife Service.

"WETLANDS GAZETTE", Estuary Edition

DEPARTMENTS	SAMPLE TOPICS
Local, Regional, and National News	-development in wetlands -related science news; research findings -beach closures due to pollution or PSP (red tide) -interview with a senior citizen describing changes surrounding an estuary
Editorials	-letters to the editor -opinions about preserving an estuary or local wetland -opinions about developing an estuary or local wetland
Sports & Recreation	-bird sightings on bays and marshes -kayaking opportunities on the bay -fishing, shellfish harvesting, hunting seasons & regulations
Community Events	-annual 2-week national "Coastweeks" celebration in September including "National Estuaries Day" -beach clean-ups; adopt-a-stream activities -local Audubon meetings
Art & Culture	-illustrations, poems, cartoons and songs about life in an estuary or wetland. -art projects using natural materials: cattails & reeds, clay, shells -photo collage of a day at an estuary

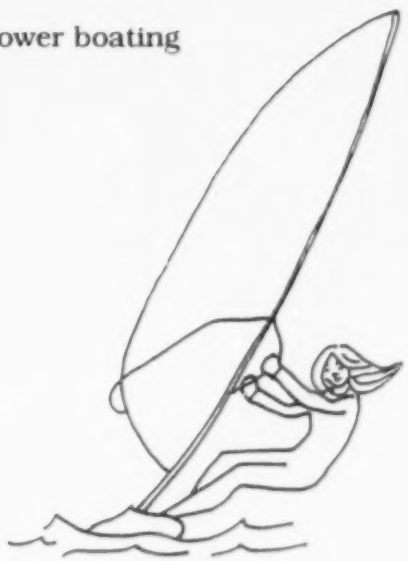
POST-TRIP IDEAS

Food	-seafood and wild food recipes from wetlands: cranberries, rice, ducks & geese -interviews with restaurants that use food from local wetlands -uses and value of algae
Advertisements	-ads for wetland-related businesses, e.g. smoked salmon, sporting goods stores -help wanted ads for related jobs, e.g. researcher, oyster farmer
Travel & Leisure	-estuaries to visit around the state, country or world -local wetlands to explore and enjoy -an interest story on Padilla Bay and the Interpretive Center
Other:	

Recreational Uses of Padilla Bay

Estuaries are visited by many local residents for sport and leisure activities. Some of these activities include:

boating: canoeing, sailing, kayaking, power boating
waterskiing
swimming
sunbathing
clam digging
hiking and walking
bird watching
wind surfing
photography
kite flying



Step #1: Make a list of the recreational uses at Padilla Bay. If possible, use photographs to support your data.

Step #2: Analyze each form of recreation as in the table below:

activity	positive effects	pollution made	negative effects
Examples:			
sailing	relaxing, fresh air	none	none
power boats	fast travel, fresh air	noise,gas,oil, and smoke	loud noise, scare birds

POST-TRIP IDEAS

Step #3: Examine the yellow pages for any business which supports these recreational activities. Pick 3 activities and list businesses that support them...

example:

sailing- boating equipment store
sailing shop
sail maker
sporting goods store
sports clothes store
etc...

1. Which business occurs regularly in your 3 activities?

2. How do these businesses benefit local residents?

FOLLOW UP - Step #4: Write a letter to one of the businesses on your list, describing the study you have done and how important estuaries are to us all.

Thanks to the Province of British Columbia,
Ministry of the Environment, for this idea.

From Marsh to Marina

ESTUARIES and SALT MARSHES can be great places to make a living. Native Americans living along the coasts knew this — and so did some of the earliest settlers. Try this activity to get your kids thinking about how people have used (and abused) these wetlands over the years.

Begin by passing out the following pages. Explain that the pictures represent some of the ways people have used wetlands through time. Have the kids cut out the pictures and then try to arrange them in order.

When everyone's finished, go over the answers. Then have each glue the pictures in the correct order on a large sheet of construction paper. (You might want to have the kids color the pictures). Have them label the time period of each picture as follows:

Picture #1 (D):	1600's
Picture #2 (B):	1700's
Picture #3 (F):	early 1800's
Picture #4 (A):	late 1800's to early 1900's
Picture #5 (C):	1950's
Picture #6 (E):	1980's

Afterward, use the following information to talk about each picture.

SALT MARSHES THROUGH TIME

Picture 1: Native Americans were the first people to use the resources of salt marshes. Around the Skagit Valley the Skagit and Swinomish hunted and fished in salt marshes and estuaries. The Indians found plenty of game in these wetlands — especially in the fall, when huge flocks of ducks and geese passed through during migration. Many of the Indians gathered oysters, clams, and other shellfish in tidal creeks and mudflats. They built fish traps out of saplings and scooped the trapped fish into cedar baskets.

Pictures 2 & 3: Many settlers lived near salt marshes during the 1700's and 1800's. Living near the marsh wasn't an easy life. For one thing, mosquitoes and other biting insects could be a terrible problem. And cattle would occasionally have to be destroyed when they sank too far down into the marsh mud to be rescued. But there were advantages to wetlands, too. There was plenty of food, and the vast fields of salt marsh hay made good grazing grounds.

Picture 4: By the later 1800's, many estuaries in North America had been settled. In some areas people began to have a big impact on the ecology of the land. Have the kids compare this situation with that depicted in the first 3 pictures. Explain that before there were so many people the marsh could easily recover from the impact people had on it. But the more people lived in a particular marsh, the more serious and long-lasting the damage that was done to it.

Ask the kids to name as many ways as they can think of that the people in this picture are affecting the marsh. Here are some things you can talk about:

* Before there were regulations on the hunting of shorebirds and other waterbirds, some species were hunted almost to extinction. Sandpipers and other salt marsh birds were hunted for their meat, and great blue herons were killed for their feathers. Their long, graceful plumes were used to decorate women's hats.

* For years, many salt marshes and other wetlands were used as dumpsites for garbage.

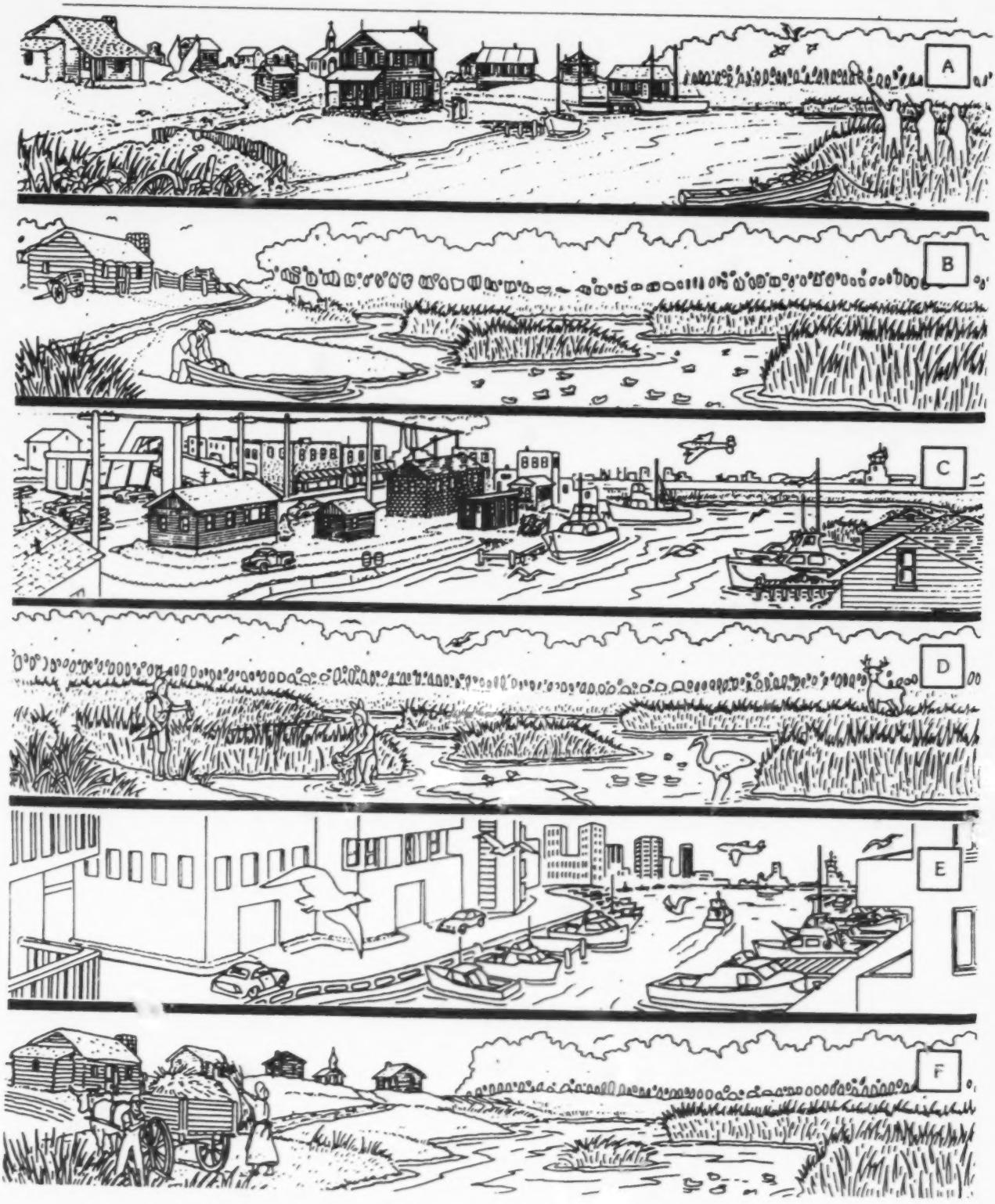
* Since there were no regulations on the dumping of sewage during this time period, water pollution was a problem in salt marshes near heavily populated areas. (Like all wetlands, salt marshes can tolerate a certain amount of sewage, but too much of it can turn a healthy marsh into a cesspool.)

Pictures 5 & 6: Point out that by the 1950's, people had drastically changed many of the original salt marshes. Few people recognized the marshes' importance in their natural state. To turn them into "useful" places, they often filled them in and built airports, houses, and other buildings on them. Ask the kids to look at the first picture again, then ask them how the wildlife in the first and last pictures differs. (There are fewer kinds of animals in Picture 6. The animals that are present are only those species that can live close to people, and a few "non-marsh" animals such as pigeons and starlings have probably moved in. Herons, shorebirds, deer, and most of the other original salt marsh animals are gone.)

To wrap up your discussion, explain to the kids that there are now laws protecting salt marshes, estuaries, and other wetlands from unwise use. Some of these areas have been designated as wildlife sanctuaries or perhaps research reserves to better study these fragile, valuable areas. Ducks, geese, eagles, deer, fish, and many other animals depend on these areas — just as they did when Native Americans hunted and fished in them hundreds of years ago.

This activity comes from Ranger Rick's NATURESCOPE,
a National Wildlife Federation publication,
Volume 2, Number 5, "Wading into Wetlands".

FROM MARSH TO MARINA



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The Value of Wetlands

Excerpts from an editorial in the Puget Sound Mail, La Conner, Washington
Thursday, November 23, 1961

PROPOSED PADILLA BAY INDUSTRIAL SITE PROJECT IS MOST DYNAMIC RECLAMATION ENTERPRISE SINCE THE PIONEERS DIKED AND DRAINED THE SKAGIT DELTA MARSHES

The proposed Padilla Bay industrial site project [building an industrial park in Padilla Bay], in our opinion is the most dynamic reclamation proposal since the days when the far-sighted and industrious pioneers diked and drained the marshes of the Skagit Delta to develop some of the finest farm lands in the nation. No doubt in pioneer times there were some who were against change and who thought it would be foolish to try and create farms out of the swampy wilderness and who felt the farms would ruin their hunting and trapping. But among the pioneers were "builders" of vision who strode forward to create. As the August edition of the Puget Sound Mail noted, it was time when "Tall Men with tall ideas came to the Tall Tree country of the Skagit." . . .

Here in Skagit County we have power, a great fresh water potential, and deep water near at hand - things of great importance to industry which can provide those needed year-around jobs. And this proposed reclamation of several thousand acres of tidelands for industrial site purposes would also help keep secure our valuable farmlands. In many states rich farmland has gone to industrial sites. In the Padilla Bay Project something new will be created instead of whittling away at the farmland. . . .

As one government man is reported to have stated when first viewing the proposed development: "Of all the proposed industrial areas in the U.S., this takes nothing from anything else - it creates something new, from tidelands."

The Value of Wetlands

An editorial from the Anacortes American, Anacortes, Washington
Wednesday, July 26, 1989

BUSH, REST OF NATION DISCOVER WETLANDS ARE WORTH SAVING

They used to be considered useless land, suitable only for man to drain, fill and exploit.

We now call them wetlands, and a lot of people — from President Bush on down — think they must be saved. Bush has promised that not a single wetland will be lost during his administration. What a change from Ronald Reagan, who did not consider preservation of the environment to be a pressing matter.

Wetlands are saturated soil formations — bogs, swamps, marshes and the like. Man has been destroying them at an alarming rate. In a lengthy essay on the environment published this week, *Newsweek* magazine reported that about 500,000 acres of wetlands a year have been filled. A prominent regional example is the Snohomish River delta between Everett and Marysville, which has been filled in over the years for farms, sawmills and a freeway.

Why did this happen? Because previous generations believed wetlands were no big deal. And as far as visual appeal is concerned they still pale in comparison to virgin forests and wilderness areas. But as *Newsweek* points out, they are ecologically more significant than the national parks and wildlife preserves that attract far more attention.

In fact, *Newsweek* lists saving the wetlands as one of five key environmental issues for the 1990s.

Folks on Fidalgo Island knew about the importance of wetlands long before *Newsweek* gave big play to the subject. The Evergreen Islands environmental-activist group has been taking a close look at wetlands in and around Anacortes. Local Audubon Society members are gearing up for an ambitious survey of all wetlands in Skagit County.

Why are wetlands important? Why should you care about an unattractive swamp? Because wetlands are prolific breeders of life ranging from the mundane (snails) to the spectacular (bald eagles). When we fill in and pave over a wetland, we snuff out a frighteningly wide range of life forms.

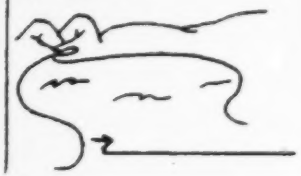
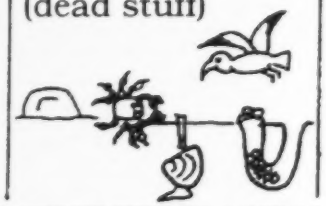
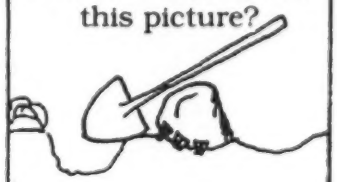
As *Newsweek* noted, wetlands have another important characteristic: they act as natural filters for removing pollutants from water. Man-made wetlands have been used to treat municipal sewage, and a citizens' group is lobbying for the wetlands-sewage approach instead of an expensive, federally mandated secondary sewer-treatment plant here. They're on to a good idea, but there's no hard evidence yet on whether their proposal would suit Anacortes. What's more, the city may not be able to escape from terms of the federal mandate, if town officials choose to do so.

The tools are in place to protect natural wetlands from development, although the Environmental Protection Agency can and does make exceptions to the rules. It remains to be seen whether Bush's promise can be kept.

But at least our leaders now are talking about saving wetlands, not just about filling in swamps.

Padilla Bay's whiz quiz!

My name is _____

Where a river meets the sea is an . . . 	What two kinds of water mix in a estuary? 1. _____ 2. _____	How many times each day does the tide come in? CIRCLE: 1 2 3 4 5	DRAW an animal that swims in with the tide.	ZOOplankton are tiny _____ _____ plankton are tiny plants.
Circle those that eat detritus. (dead stuff) 	Invent some ZOOPLANKTON	Free!	Connect the FOOD CHAIN with arrows	Do YOU like to eat: YES NO 1. clams ☐ ☐ 2. crabs ☐ ☐ 3. oysters ☐ ☐ 4. salmon ☐ ☐ 5. seaweed ☐ ☐
Connect: Animal → Habitat plankton → on mud barnacle → in mud crab → under rocks snail → on rocks claim → in water	Give this FLOUNDER a home.	What is WRONG with this picture? 	Which plants grow in wetlands? ☐ spinach ☐ cattails ☐ roses ☐ seaweeds ☐ dandelions ☐ eelgrass ☐ saltgrass ☐ sea lettuce	DRAW an animal that lives on rocks.

LET'S FIND NATURE'S GARBAGE CAN!

Is dead seaweed garbage? Follow these directions to find the answer...

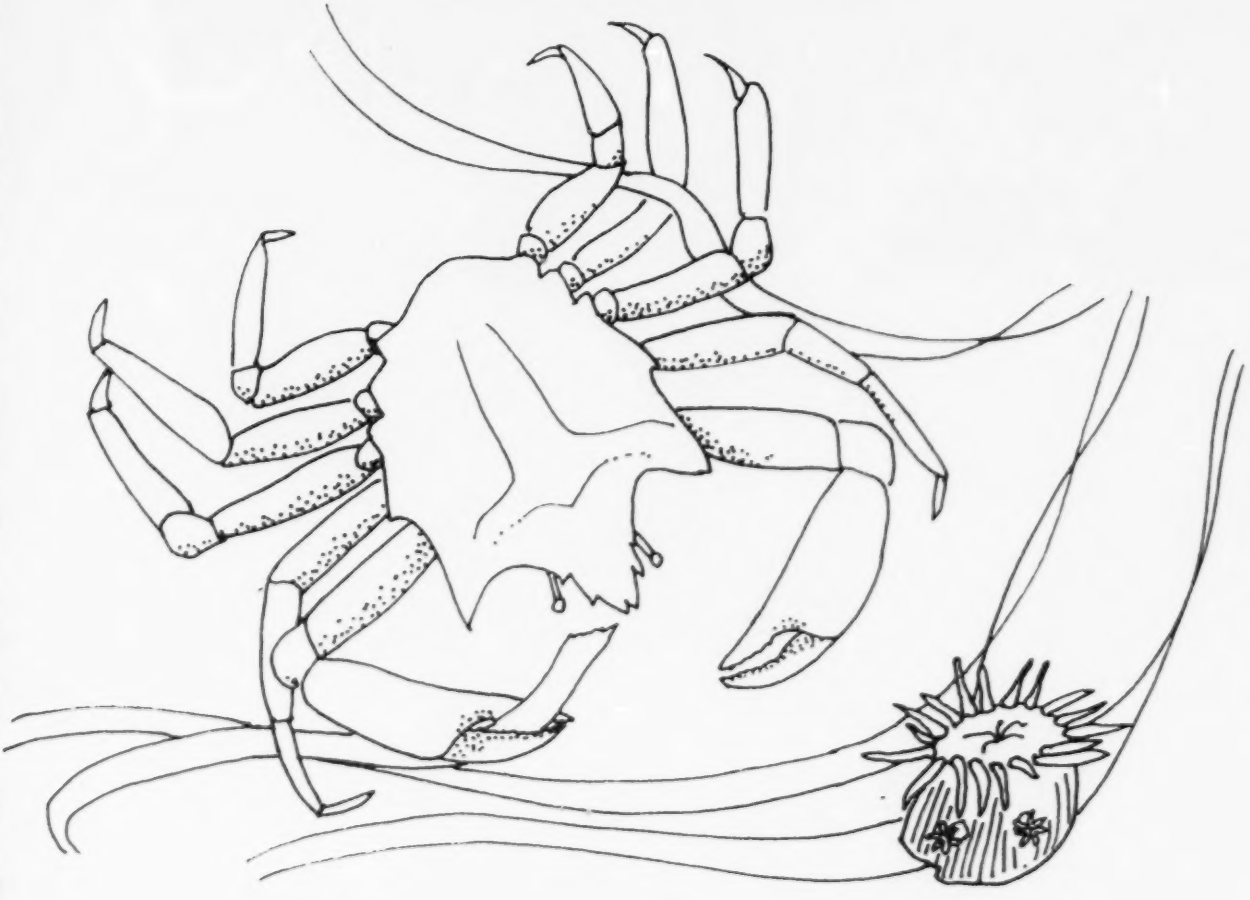
1. Seaweed gets washed up on shore. Is it garbage?
   __Yes.Go to #12.
   __No.Go to #9.
2. Wrong. Nothing stays in the soil. __Now go to #11.
3. Right! Crabs, snails, worms, seagulls and other animals often eat dead things. Are there animals which eat live creatures?
   __Yes.Go to #8.
   __No.Go to #6.
4. Wrong. Rotting is just another natural process for an animal.
   __Now go to #5.
5. Right. When bacteria and fungi "rot" things, they return them to the soil. Is this where nature's garbage can ends up?
   __Yes. Go to #2.
   __No. Go to #11.
6. Wrong. Animals like seals and great blue herons, for example, eat other animals. __Now go to #8.
7. Wrong. The nutrients in the bodies of dead things are not wasted in nature. __Now go to #3.
8. Right! These animals are called predators. If an eagle eats a salmon and then flies away and dies and rots, is it garbage?
   __Yes. Go to #4.
   __No. Go to #5.
9. Right! Many small animals like the Beach Hopper, live in dead seaweed. But what about these animals? Do they just die and become waste?
   __Yes. Go to #10.
   __No. Go to #13.
10. Wrong. There are billions of these small animals hatched every day. If they died and did not rot the world would soon be buried in their bodies.
    __Now go to #13.

11. Right! Plants will use the nutrients from the soil and more seaweed will grow to replace what has died. And that brings us back to where we started...at #1. There is no garbage in nature, because everything is re-used again and again in a circle.
12. Wrong. Dead seaweed has many uses. __Now go to #9.
13. Right! Small animals are eaten by bigger animals like birds, for instance. If a sandpiper eats a beach hopper, then later the sandpiper dies, will its body be of any use?

__Yes. Go to #3.

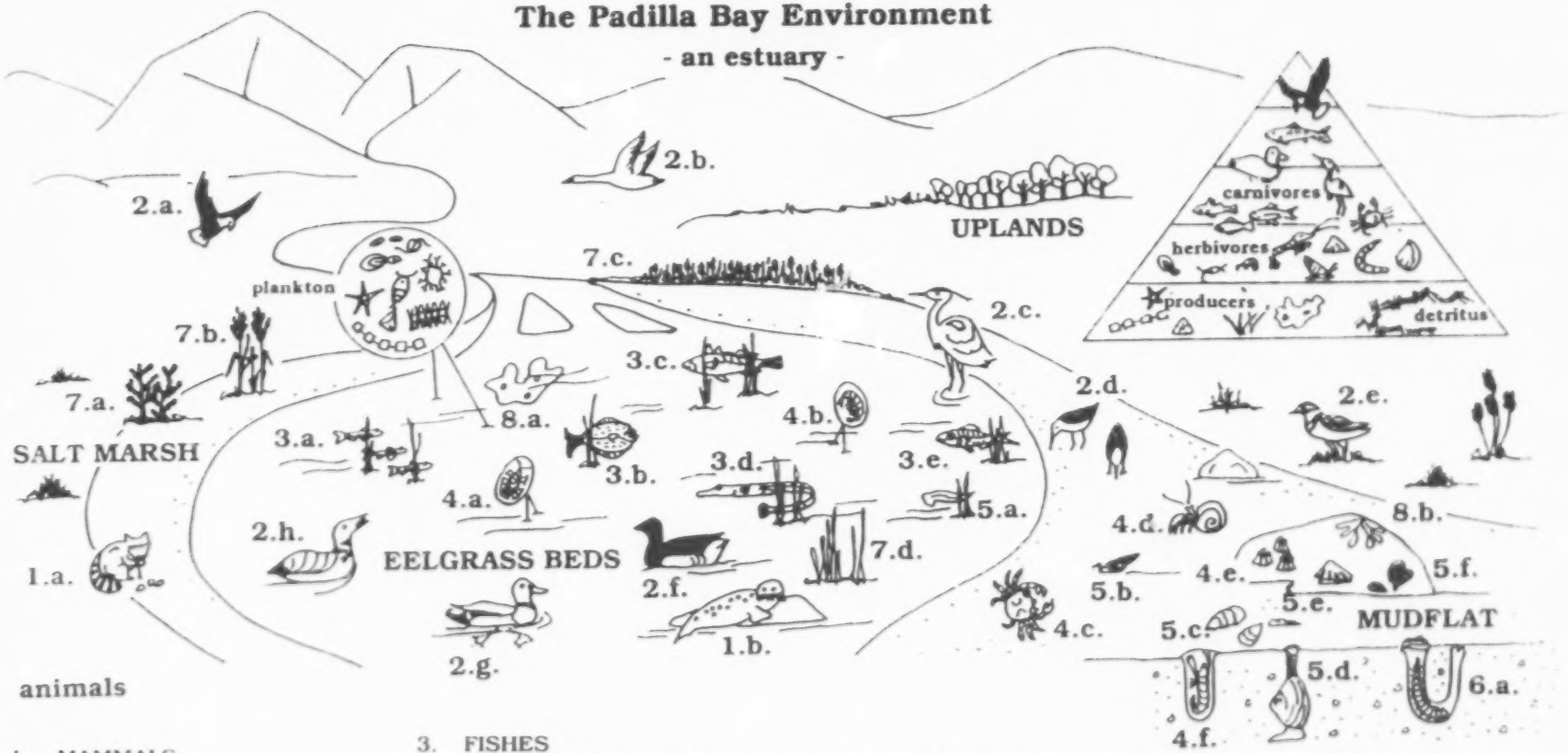
__No. Go to #7.

Adapted from the "Encore" kit



The Padilla Bay Environment

- an estuary -



animals

1. MAMMALS
   - a. Raccoon (*Procyon*)
   - b. Harbor Seal (*Phoca*)

2. BIRDS
   - a. Bald Eagle (*Haliaeetus*)
   - b. Tundra Swan (*Olor*)
   - c. Great Blue Heron (*Ardea*)
   - d. Western Sandpiper (*Calidris*)
   - e. Killdeer (*Charadrius*)
   - f. Black Brant (*Branta*)
   - g. Mallard (*Anas*)
   - h. Common Loon (*Gavia*)

3. FISHES
   - a. Juvenile Salmon (*Oncorhynchus*)
   - b. Starry Flounder (*Platichthys*)
   - c. Stickleback (*Gasterosteus*)
   - d. Pipefish (*Syngnathus*)
   - e. Herring (*Clupea*)

4. ARTHROPODS
   - a. Eelgrass Isopod (*Idotea*)
   - b. Amphipods (*spp.*)
   - c. Purple Shore Crab (*Hemigrapsus*)
   - d. Hermit Crab (*Pagurus*)
   - e. Acorn Barnacle (*Balanus*)
   - f. Mud Shrimp (*Upogebia*)

5. MOLLUSKS
   - a. Taylor's Sea Hare (*Phyllaplysia*)
   - b. Mud Snail (*Batillaria*)
   - c. Pacific Oyster (*Crassostrea*)
   - d. Mud Clam (*Mya*)
   - e. Shield Limpet (*Collisella*)
   - f. Blue Mussel (*Mytilus*)

6. WORMS
   - a. Lugworm (*Abarenicola*)

plants

7. HIGHER PLANTS
   - a. Pickleweed (*Salicornia*)
   - b. Salt Grass (*Distichlis*)
   - c. Cattails (*Typha*)
   - d. Eelgrass (*Zostera*)

8. ALGAE
   - a. Sea Lettuce (*Ulva*)
   - b. Rockweed (*Fucus*)

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Looking Into An Estuary

Look closely at the plants and animals below. Where would they most likely live? Cut out the pictures and glue them in their habitat.

grasshopper

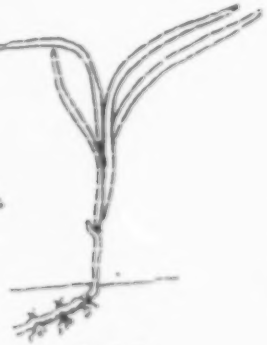
amphipod

littleneck clam

bent-nosed clam

oyster

seaweed


eelgrass

mud snail

barnacles

limpet

mussels

lugworm

ribbon worm

shore crab

sea lettuce

eagle

great blue heron

stickleback

pipefish

Dungeness crab

mud shrimp

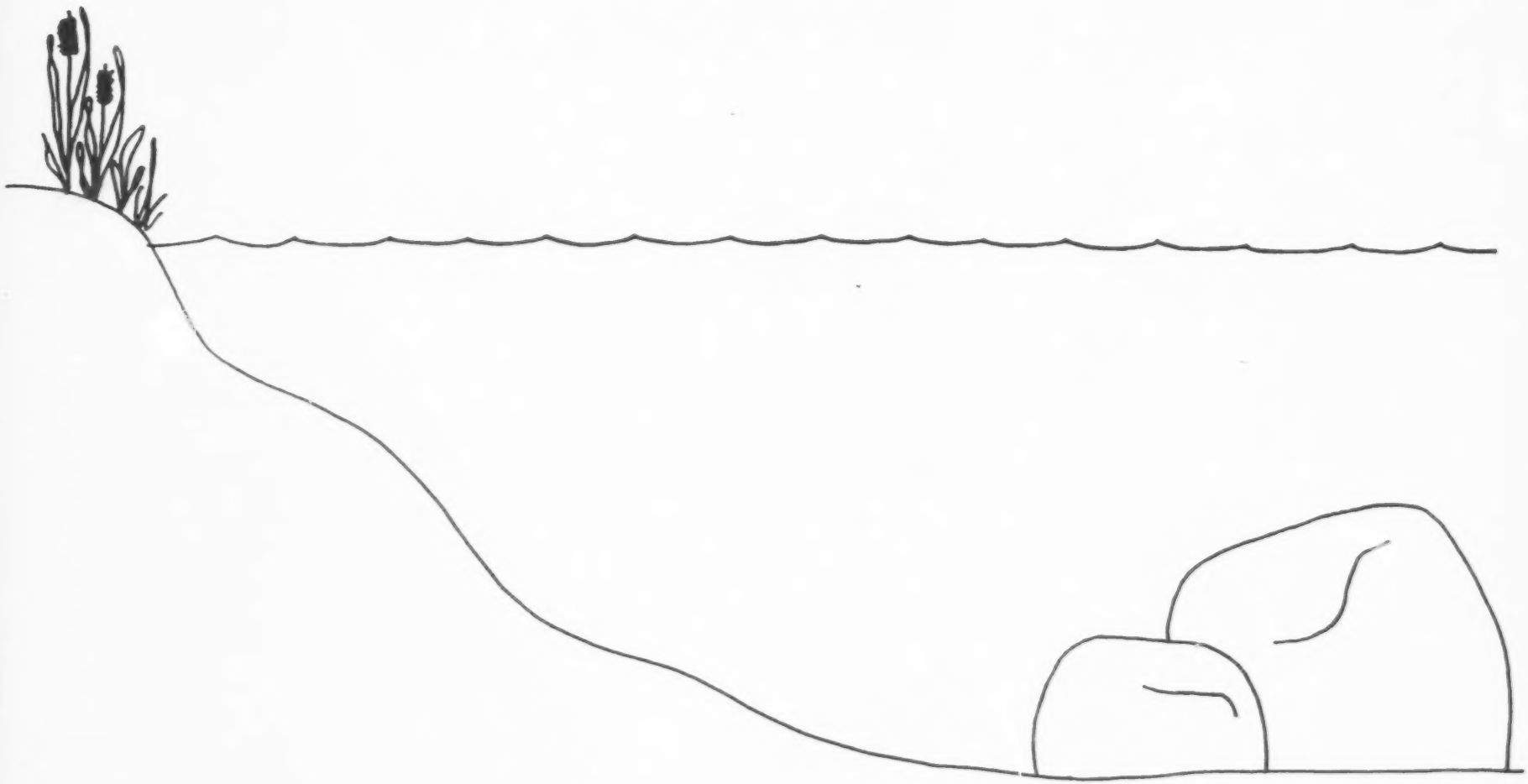
harbor seal

gunnel

flounder

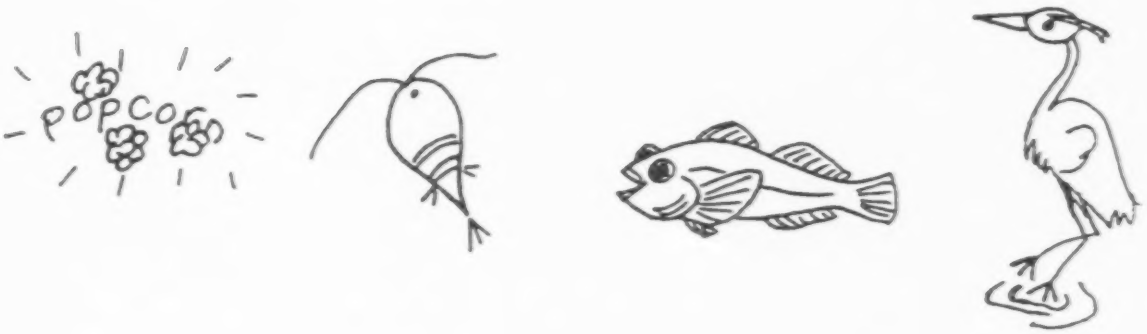
raccoon

Looking Into An Estuary



Food Chain Game

Teacher Background: The transfer of food from its source - plants - to one or more organisms is called a FOOD CHAIN. This transfer occurs when one organism eats another. The food chain in this game consists of four links:



phytoplankton (tiny plants)	zooplankton (tiny animals)	sculpins	great blue herons

Popcorn represents the phytoplankton. Students play the roles of zooplankton (plant eaters), sculpins (which eat zooplankton), and great blue herons (which eat the sculpins). The object of the game is for each species or POPULATION to survive the timed course of the game.

A POPULATION is a group of organisms of one kind that lives in the same area. Large natural populations are usually able to withstand the loss of some of their individuals. In our populations, the survival of one of each kind of animal is considered a success. The community is balanced and will survive.

Food Chain Game Directions

You will need:

1 large paper bag of unsalted popcorn
1 timer
roll of 1" masking tape
1 plastic sandwich bag for each student
color coded "sashes"

Preparations: Before you are ready to begin the game, you will need to prepare the stomachs and colored "sashes". Stomachs are made by placing a strip of masking tape parallel to the bottom of the bag, 1-1/2" from the bottom.

Sashes should be made from colored paper or material. For every 3 students, make 2 zooplankton sashes, 1 sculpin sash, and 1 great blue heron sash.

How to play:

1) Briefly review food chains. Outline the boundaries of the game area, an area of approximately 15 yards square. This game is best played outdoors or on an uncarpeted area.
2) Spread most of the phytoplankton (popcorn) over the area. Tell your class you are spreading out the phytoplankton for the zooplankton to eat.
3) Divide the students into 3 groups and distribute the sashes and plastic bag stomachs. Give a third of the students zooplankton sashes and tell them they need to fill their plastic bags with popcorn to the bottom of the tape to survive. Give another third of the students sculpin sashes and instruct them to fill their bags to the top of the tape. The final third of the students are great blue herons who need to fill their plastic bag stomach to the top to survive. Great blue herons survive by eating (tagging) sculpins. Sculpins survive by eating (tagging) zooplankton, and zooplankton eat the phytoplankton (popcorn). If a great blue heron tags a sculpin the sculpin must

surrender the contents of its stomach and leave the game. If a sculpin tags a zooplankter, the zooplankter must surrender the contents of its stomach to the sculpin and leave the game.

4) State the challenge. Set the timer for five minutes and say "GO!" The first game usually lasts only a few seconds with one of two things happening. The zooplankton are gobbled up before they have a chance to forage, or the sculpin are gobbled up and the zooplankton continue to eat popcorn.

5) Analyze the results. How many animals survived? Repeat the game. Try different rules that might result in more of a balance between the animals.

a. Change the number of zooplankton and/or sculpins and/or herons.
b. Let each zooplankter come back as another zooplankter once after being recaptured and transferring its stomach contents.
c. Provide a "safety zone" for zooplankton and/or sculpins.
d. Timed releases. Let zooplankton go first to forage. One minute later release the sculpins and later the herons.

Conclusion: Analyze the results of each game. How many zooplankton filled their stomachs? How many sculpins? How many great blue herons? Compare game results after each rule change and comment on how the game balance compares with the balance in the real world. What would happen if there were only half as many popcorn phytoplankton? If there were no sculpins what would happen to the zooplankton population?...the great blue heron population? Do great blue herons need plants to survive? Are there any plants or animals that are not part of any food chain? What happens to the great blue heron? (dies, decays, "nutrients" recycle back into the system). Who will eat the leftover popcorn?

Adapted from: Outdoor Biology Instructional Strategies
Lawrence Hall of Science, University of California
Berkeley, CA 94720

HUMAN USES OF AN ESTUARY

In estuaries and marshes there are a lot of things people can do. Some things destroy habitat, some do not.

List things that people do in our wetlands that <u>do not</u> destroy the habitat:

1._____ 5._____
2._____ 6._____
3._____ 7._____
4._____ 8._____

List some things that people have done on our tide flats that <u>do</u> destroy habitat for birds or other creatures.

1._____ 5._____
2._____ 6._____
3._____ 7._____
4._____ 8._____

Some of these things may be necessary if we are going to have a place for people. Some could be done elsewhere. Which of the habitat destructive items you listed probably could have been done someplace else?

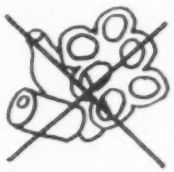
1._____ 5._____
2._____ 6._____
3._____ 7._____
4._____ 8._____

Adapted from Alaska Sea Grant curriculum

Key

HUMAN USES OF AN ESTUARY

In estuaries and marshes there are a lot of things people can do. Some things destroy habitat, some do not.



List things that people do in our wetlands that <u>do not</u> destroy the habitat:

1. swim
2. boat
3. bird watch
4. picnic
5. fly kites
6. live nearby
7.
8.

List some things that people have done on our tide flats that <u>do</u> destroy habitat for birds or other creatures.

1. hunt
2. dredge - boats
3. dike - farm
4. drain - building
5. fill in - building
6. dump in - garbage
7.
8.

Some of these things may be necessary if we are going to have a place for people. Some could be done elsewhere. Which of the habitat destructive items you listed probably could have been done someplace else?

1. farm
2. build
3. dump garbage
4. hunt
5.
6.
7.
8.

Adapted from Alaska Sea Grant curriculum

ESTUARY 3-D BOARD

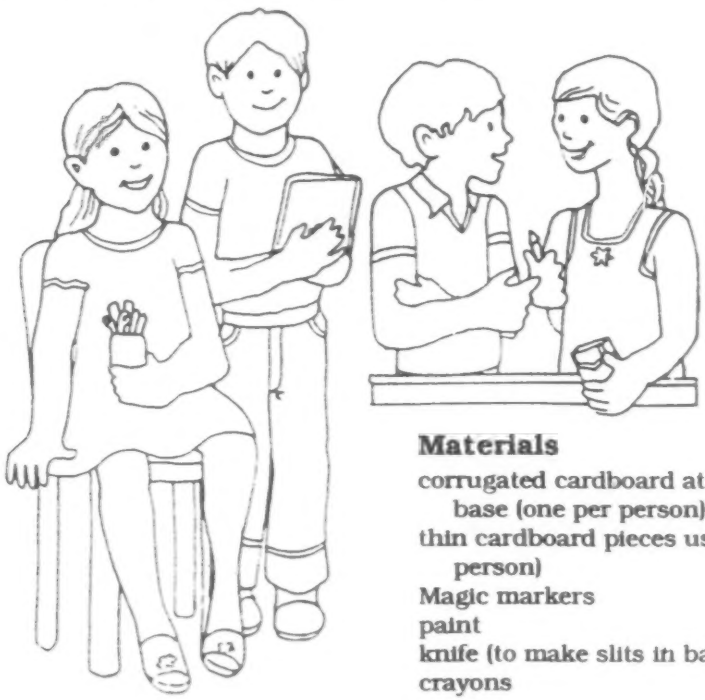
Introduction

A healthy estuary fringed by its streams, marshes, and shores forms a very productive biological system. The marshes provide nutrients to the estuary which cycle efficiently from plants to animals to soil and around again through the food web. The marshes provide undisturbed nursery grounds, and the life cycles of the plants and animals maintain a natural balance.

When people enter the estuary environment they make changes. They catch fish, dredge oysters, dig for clams and trap crabs. In addition, they add undesirable substances to the water: industrial chemical wastes, large quantities of nutrients from municipal sewage discharges, and the silt and sediment runoff from construction sites. To keep navigable channels clear, to provide sites for dredging spoils and create more land for construction, marshes are often drained and filled. Tankers pump their ballast tanks and cause oil slicks. All of these activities disrupt food chains.

An evaluation of the health of an estuary, both idealized and showing humanity's negative influences, can be accomplished by creating a 3-dimensional board which when looked at from one side indicates the conditions which make a healthy estuary, and when turned around shows how humans interfere, inadvertently or intentionally, with the estuarine system.

Make An Estuary Environmental Board

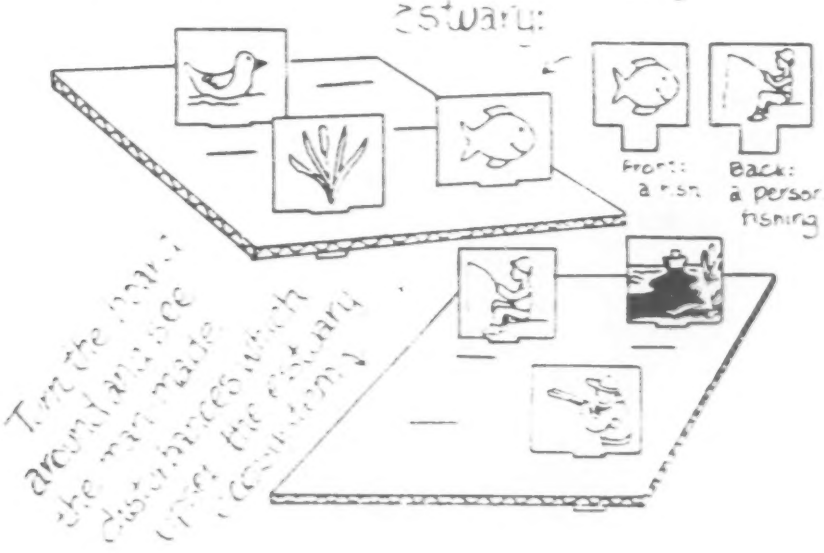


Materials

corrugated cardboard at least 25 cm by 25 cm for base (one per person)
thin cardboard pieces usable on both sides (10 per person)
Magic markers
paint
knife (to make slits in base)
crayons
scissors

from the Chesapeake Sea Grant curriculum

Get these supplies:
Thin cardboard- cut into squares, with tabs on the bottom
Corrugated Cardboard
cut slits for the tabs
paints, crayons, scissors, markers, knife, water for paints.
don't forget clean-up materials.


One side of your 3-D Board will show some elements of a healthy estuary:
Front: a fish
Back: a person fishing
Turn the page around and see the same board with disturbances to the estuary (human activities).

BEST COPY AVAILABLE

Preparation

Cut some of the thin cardboard into squares (see illustration) with tabs on the bottom. Cut slits for tabs in one piece of the base (corrugated cardboard) to use as a demonstration. For younger groups you may want to make slits in bases ahead of time.

Procedure

1. Explain to the participants that they are display designers of a museum with the task of making a 3-dimensional model of an estuary. They have already completed the background research (the previous activities). The model is to be viewed from two sides. When it is looked at one way, the model is to show a healthy estuary ecosystem, and when turned around, it is to show how people can upset the balance of the system.
2. Demonstrate how to make the board using the base with slits and one of the pre-cut thin cardboard pieces. Draw a member of a food chain, such as a fish, on one side and a man-made disturbance, such as a girl fishing, on the other. Put the tabs of the piece into the slits on the base. turn the board so participants can view both sides.
3. Give each person a baseboard and some thin cardboard pieces to design an estuary board. When all the cardboard pieces are in place, the baseboard can be decorated. It may be necessary for the leader to cut the slits in the baseboard.
4. Discuss the participants' boards: have them explain the subjects chosen.

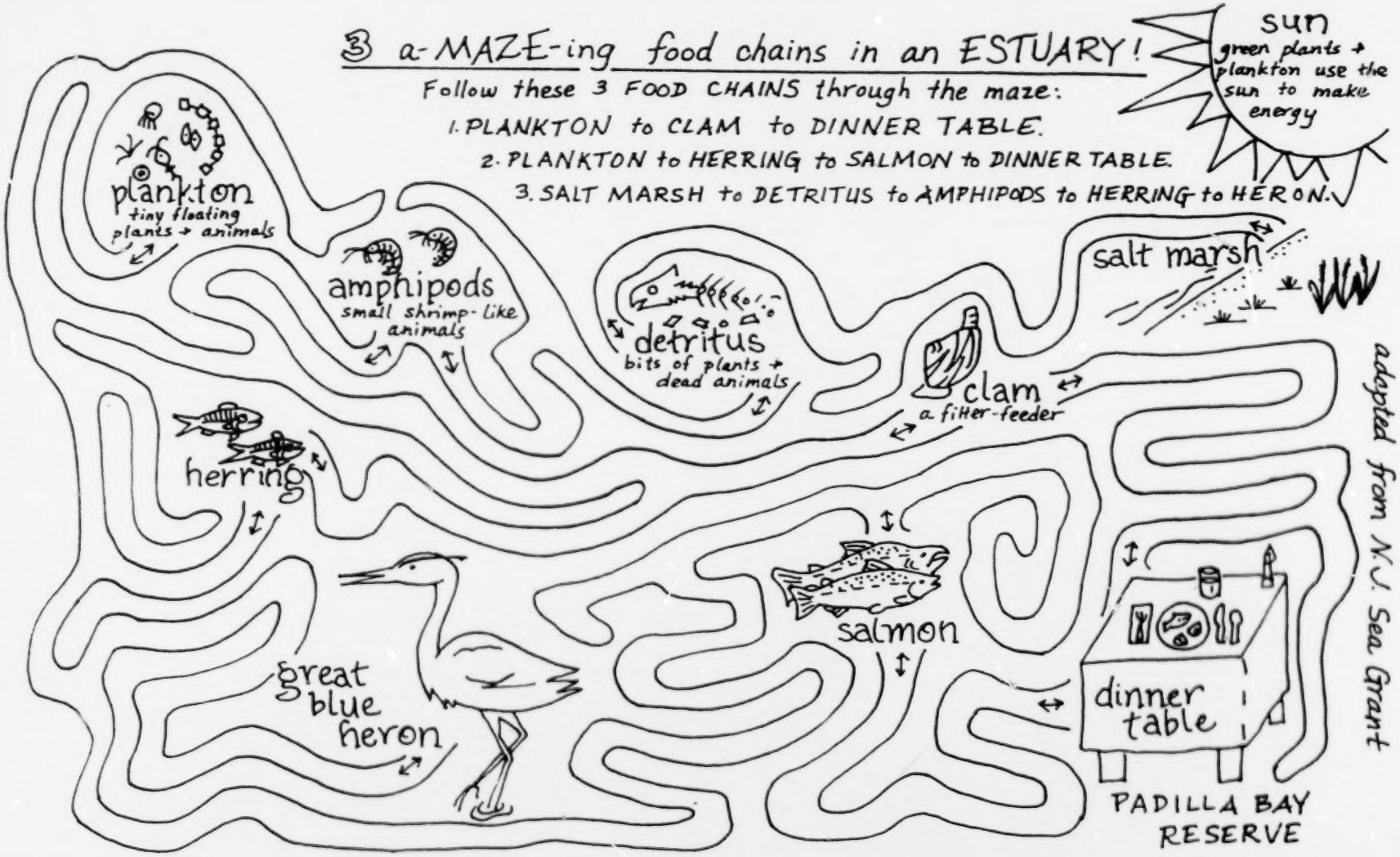
Questions

1. Are all human interferences in the estuary harmful?
2. Do natural forces, such as hurricanes, also upset the equilibrium in an estuary? How?
3. How would an addition of fertilizer affect an estuary? Kepone? Herbicides?

3 a-MAZE-ing food chains in an ESTUARY!

Follow these 3 FOOD CHAINS through the maze:

1. PLANKTON to CLAM to DINNER TABLE.
2. PLANKTON to HERRING to SALMON to DINNER TABLE.
3. SALT MARSH to DETRITUS to AMPHIPODS to HERRING to HERON.

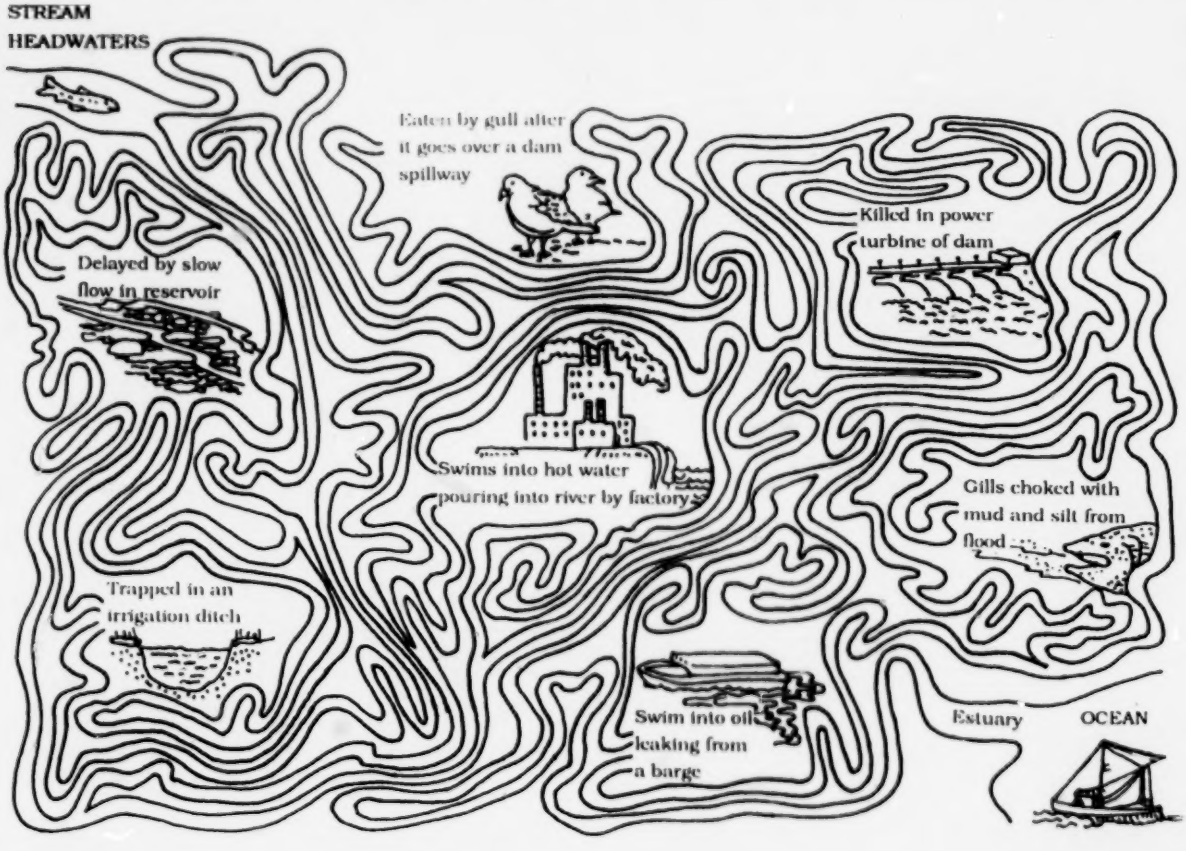


SALMON MAZE

You may already know that adult salmon migrate from the ocean to their home streams when they are ready to lay eggs. But we often forget about an even more dangerous journey . . .

Young salmon must head out from their nests and travel down river past all sorts of hazards. Out of 2,500 coho salmon eggs, only 6 will ever make it to the ocean!

See if you can safely get the young salmon from their stream to the estuary.


STREAM
HEADWATERS
Eaten by gull after it goes over a dam spillway
Killed in power turbine of dam
Delayed by slow flow in reservoir
Swims into hot water pouring into river by factory
Gills choked with mud and silt from flood
Trapped in an irrigation ditch
Swim into oil leaking from a barge
Estuary
OCEAN

thanks to the U.S. Fish and Wildlife Service for this activity

Many animals feed on other animals. What might eat this fish?

Afternoon In an Estuary

A creative drawing (and listening!) exercise to be read aloud to your class as they draw.

Imagine that you are in a motor boat going down a river. After two hours of motoring downstream, you come to the mouth of the river where it meets the ocean. This area, where fresh water from the river meets the salt water from the ocean, is called an ESTUARY. In the center of your paper near the top, draw yourself and the boat on top of the water in the estuary... Because the tides from the ocean can pull your boat further out to sea, you will need your motor on. Indicate that your motor is "on"....

Although the estuary will be deep where the main channel of the river is, it will be shallow along the shore and in much of the estuary itself. Draw some areas of shallow bottom under your boat.... Now draw yourself lowering a rope to measure the depth of the estuary....

Because the water is so shallow in an estuary, a lot of sunlight can get through the water to the plants that grow on the bottom. Draw lots of seaweed and grasses on the estuary's floor.... The rivers that flow into the estuary carry soil from the land, bringing lots of nutrients for the plants to use for making food. This, the sunlight, plus the combination of fresh and salt waters, allows many plants to grow. Many more plants tend to grow in an estuary than in a similar area in the open ocean.

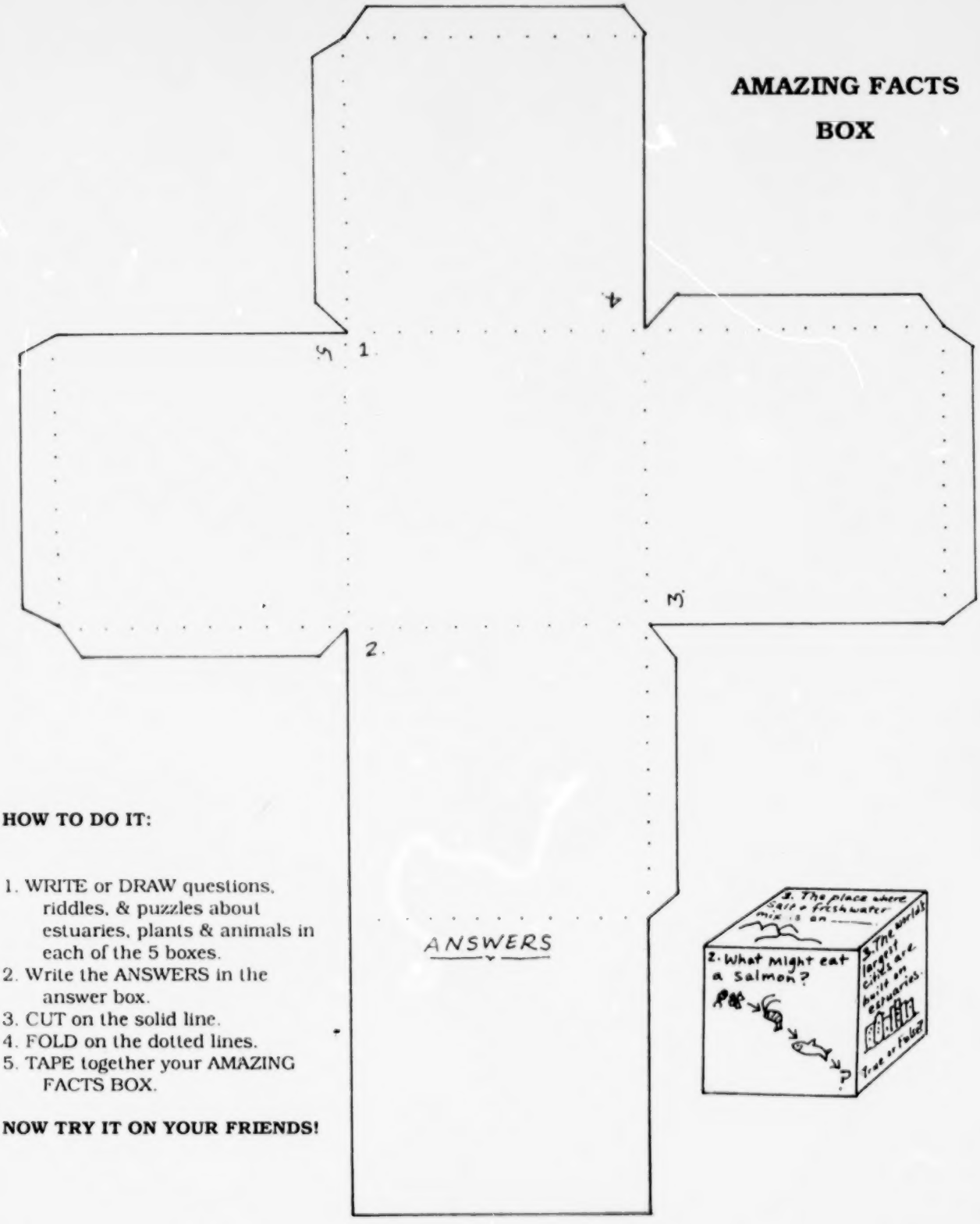
But many of these plants are so tiny that one needs a microscope in order to see them! These, in turn, are eaten by tiny animals. These tiny plants and animals that live suspended in the water are called PLANKTON. Draw lots of these microscopic plants and animals in the water under your boat....

Many animals and fish live on this floating food by filtering it from the water. Draw a barnacle, one of the filter-feeders, on a rock in the bottom of your estuary....When animals and plants die, they drift to the bottom and decay, becoming DETRITUS. Crabs are one of the scavengers that live on this decaying matter. Draw a crab on the bottom....

Small fishes not only find food in an estuary, they can also hide from predators in the seaweed and grasses. Draw lots of little fishes, feeding and hiding in the grasses.... Because there are so many little fish, larger fish will live in an estuary to try and catch them. Draw a large salmon looking for a tasty meal.... Now draw an animal that might eat a salmon — for example, a harbor seal or bald eagle.... Now that you know that there are large salmon in your estuary, you are getting hungry. On the back of your paper, draw yourself eating a tasty meal from an estuary....

Adapted from "Clean Water, Streams, and Fish",
Washington State Office of Environmental Education

AMAZING FACTS BOX



HOW TO DO IT:

1. WRITE or DRAW questions, riddles, & puzzles about estuaries, plants & animals in each of the 5 boxes.
2. Write the ANSWERS in the answer box.
3. CUT on the solid line.
4. FOLD on the dotted lines.
5. TAPE together your AMAZING FACTS BOX.

NOW TRY IT ON YOUR FRIENDS!

3. The place where salt & fresh water mix is an ____
2. What might eat a salmon?
5. The world's largest cities are built on estuaries.
True or False?

CRITTER CREATIONS

Ask each student to choose one animal or plant from the "Critter List". Using resources from the list on page 138 have them research it to find out:

a) what their organism looks like
b) where it lives
c) how its fits into the food web.

Using modeling clay, instant paper mache or one of these clay recipes, have them shape their animal/plant, let it dry, and paint it. Follow-up activities may include written and oral presentations, or a class project building an estuary diorama.

Cornstarch Clay (requires stove or hot plate)
2 parts table salt
1 part cornstarch
1 part water
Mix and cook over low heat until stiff. Add a few drops of cooking oil to delay drying. Shape figures when cool. Let dry 2 days or dry 1 hour in oven before painting.

Baker's Clay Playdough (requires oven)
4 cups flour
1 cup salt
1-1/2 cups water
Mix and knead; if too stiff, add water. Shape into figures. Bake 1 hour in 300° oven or until hard. When cold, paint. To keep, spray with a fixative or shellac. Dough will keep moist in a plastic bag.

above recipes from Making Things by Ann Wiseman

CRITTER LIST

Invertebrates
jellyfish
anemone
ribbon worm
lugworm
sand worm
barnacle
beach hopper (sand flea)
eelgrass isopod
mud shrimp
hermit crab
Dungeness crab
shore crab
sponge
limpet
mud snail
bubble shell
bent-nosed clam
littleneck clam
mud clam
edible mussel
oyster
sea star

Fishes
herring
salmon
surf smelt
bay pipefish
3-spine stickleback
shiner perch
sculpin
flounder
rockfish

Mammals
raccoon
river otter
harbor seal
muskrat

Birds
common loon
great blue heron
black brant
mallard
sandpiper
dunlin
peregrine falcon
bald eagle
sea gull
bufflehead

Plants
eelgrass
algae (seaweed)
phytoplankton
salt grass
pickleweed

THE ESTUARY FOOD CHAIN SONG

Tune: Farmer in the Dell

1. The plants soak up the sun,
   The plants soak up the sun,
   Hi Ho the food chain goes,
   The plants soak up the sun.

2. The dying plants decay,
   The dying plants decay,
   Hi Ho the food chain goes,
   The dying plants decay.

3. The pods* eat detritus,
   The pods eat detritus
   Hi Ho the food chain goes,
   The pods eat detritus.
   *amphipods and copepods

4. The smelt eat the pods,
5. The herring eats the smelt,
6. The seal eats the herring,
7. The seal meets its end,
8. The animals decay,
9. The scavengers move in,
10. And 'round and 'round it goes.

Can you make up your own verses?

Everything in nature changes; this program, too, is evolving. We are always in need of, and grateful for, your ideas and constructive feedback. Please take ample concentrated time to give us your thoughts. All comments will be read seriously and assimilated.

Thank you so much!

State of Washington
Department of Ecology
Padilla Bay National Estuarine Research Reserve
Breazeale-Padilla Bay Interpretive Center
1043 Bayview-Edison Road * Mount Vernon, Washington 98273
(206)428-1558

The Estuary Program - Level 2
Evaluation

1. Teacher_____
2. School_____
3. Grade/age of group_____
4. Date of visit_____
5. What do you remember best from this visit?_____
   _____
6. Did this program meet your expectations? _____ Why or why not?____
   _____
7. Did the program fit with your classwork? _____ How?_____
   _____
8. Which components of the day were most valuable?

	valuable				not valuable	comments
pre-trip information	1	2	3	4	5	_____
intro in theater	1	2	3	4	5	_____
mudflat safari	1	2	3	4	5	_____
plankton viewing	1	2	3	4	5	_____
exhibits & aquaria	1	2	3	4	5	_____
"chalk talk"	1	2	3	4	5	_____
simulation game	1	2	3	4	5	_____
post-trip ideas	1	2	3	4	5	_____

9. Was the time used wisely? _____ Would more or less suit better?
   How?_____
10. How will you follow up the visit? (discussion,activities)_____
    _____

11. Did you attend a teacher orientation workshop? _____ Did it adequately help you prepare for this field trip? _____ What further information would have been helpful?_____

_____

12. Did you personally gain from this experience? _____ How so?_____

_____

13. Any comments from the adult volunteers?_____

_____

14. Did the educators appropriately meet the level of your students?___ How comfortable were you with the atmosphere?_____

15. Would there be other teachers in the school who could benefit from this program? _____ Perhaps you could fill them in.

16. Further comments, suggestions, and ideas:

Thank you for taking the time to fill out this form. All comments will be considered and appreciated.

To return, simply fold and place stamp on this form

_____

_____

_____

☐ Would you like to be on our mailing list for our seasonal calendar?

Padilla Bay National Estuarine Research Reserve
1043 Bayview-Edison Road
Mount Vernon, WA 98273

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